POWER

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Take a Good Look at This Picture

Suppose the crane and tackle holding this great turbine should break. Those under it would be killed, those about it perhaps seriously injured. They feel sure it won't fall. They have confidence in the designer of the crane and tackle and trust the man who operates them.

More than this. They know the owners of the crane and equipment take every precaution to prevent such accidents by being critical in the selection of men and material.

The average citizen has only a vague conception of the potential danger in a boiler under high pressure. He has confidence in the skill and judgment of the attendant. In states and cities where boiler laws prevail this confidence is based on the knowledge that there is a systematic effort to be critical in the selection of men and material, just as with the handling of the turbine. In states where no such systematic efforts obtain, confidence is based on nothing more substantial than chance.

It is gratifying to know that each year, more communities act to eliminate the element of chance by creating laws that establish systematic inspection and promote safety.

The need for such laws is well known. Let every engineer unite with every other to make these laws uniform everywhere and promote universal confidence in themselves.

Vulcan Marine Steam Turbines

By Dr. Alfred Gradenwitz

SYNOPSIS—Briefly reviews the development of marine turbines by the builders of the "Imperator" and "Vaterland." Vulcan turbines are a combination of the Curtis-A. E. G. types and usually drive through hydraulic reduction gears. A total of 850,000 hp. is now in course of construction, 33,000 hp. being the largest unit.

The Vulcan Works at Stettin have had a paramount share in the development of marine turbines. In December, 1902, they undertook to build the small cruiser "Lübeck," the first turbine-driven cruiser of the German navy; the vessel was equipped with Parsons turbines. In the summer of 1904, the Vulcan works were awarded orders for the construction of the turbine steamer "Kaiser," of the Hamburg-American Line; this vessel was equipped with A. E. G. turbines. The construction of the "Stettin," the second turbine cruiser of the German navy, which was also equipped with Parsons turbines, was likewise entrusted to the Vulcan shipyards. These three vessels, with the exception of a small torpedo boat, were the first German turbine vessels. They proved most successful and the experience derived from their operation convinced the builders that steam turbines were to be received with favor as a means of ship propulsion. Further evidence of this was afforded by the rapid advance in the construction of the A. E. G. turbines for the cruiser "Mainz" of the German navy, which vessel, built in the Vulcan shipyards, exceeded, in her trials, performances stipulated by contracts.

It was at this time that the management of the Vulcan Works resolved to engage in the construction of marine turbines on a large scale. To obtain a safe beginning for this new line of work, they concluded an agreement on a royalty basis with the Allgemeine Elektrizitäts-Gesellschaft, who had all the experience of the American Curtis concern at their disposal. Coöperation on this basis has after some years developed what is now known as the Curtis-A. E. G.-Vulcan turbine system. At the Stettin and the Hamburg works of the Vulcan Works 850,000 hp. in turbines is now in course of construction, the maximum individual output being 30,000 hp.

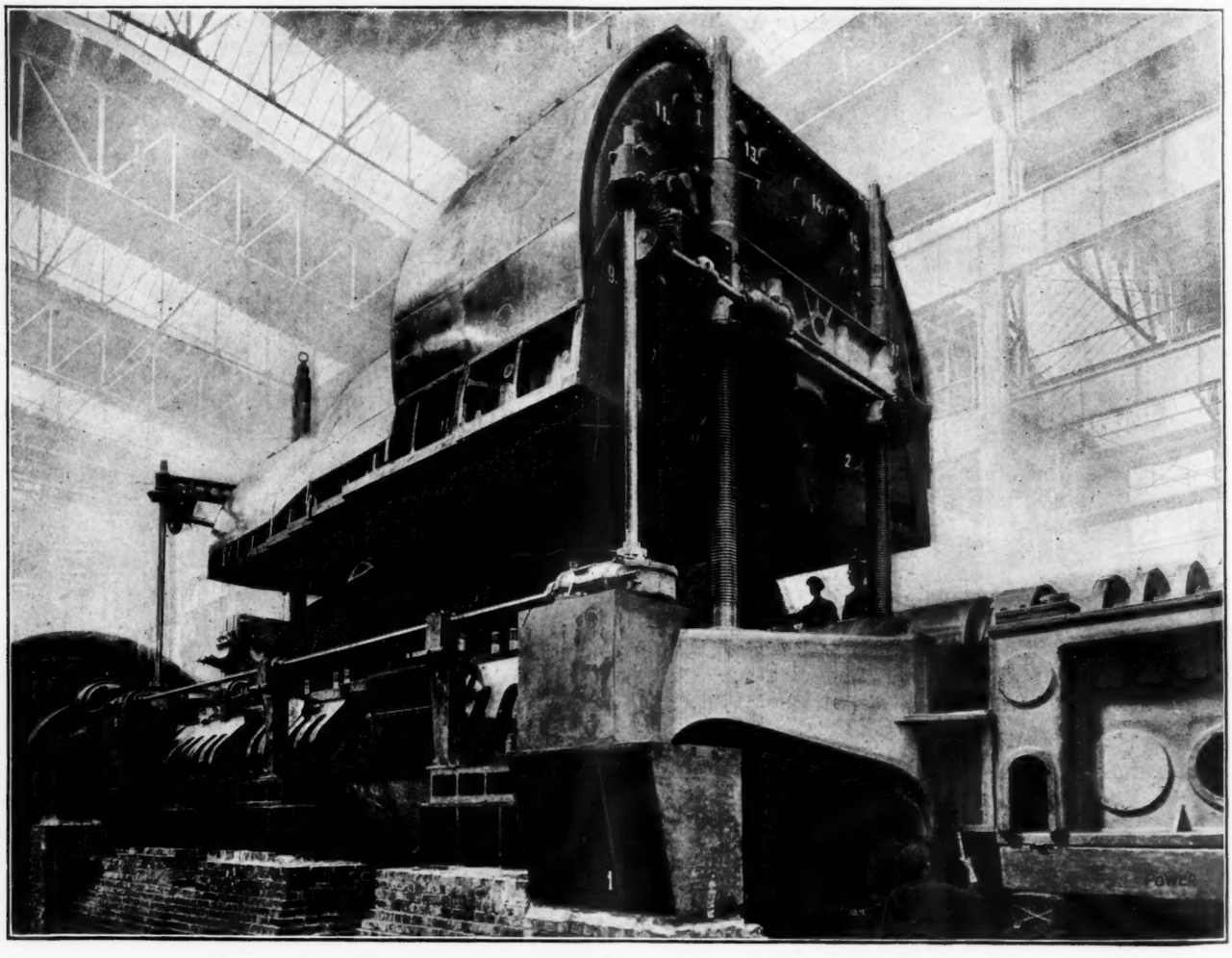


Fig. 1. The "Imperator's" 22,000-Horsepower, Low-Pressure Turbine

Fig. 1 shows the 22,000-hp., low-pressure turbine of the "Imperator." Note the motor-driven arrangement for raising the casing. Fig. 2 shows the low-pressure rotor for a turbine to be used aboard a large mercantile steamer. Note the blade lengths on the rotor, Fig. 2.

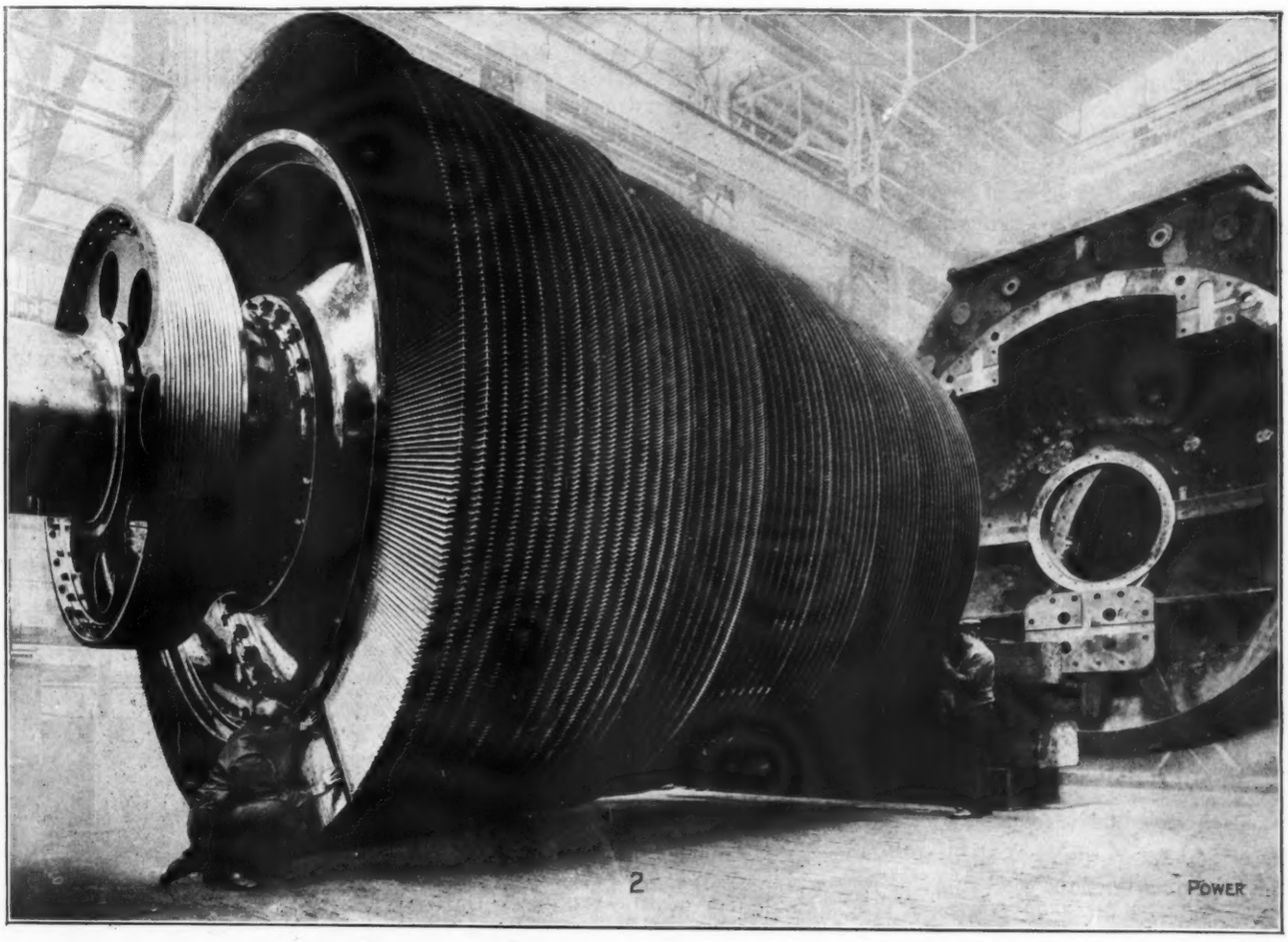


FIG. 2. ROTOR OF LOW-PRESSURE TURBINE FOR LARGE LINER; NOTE BLADE LENGTHS

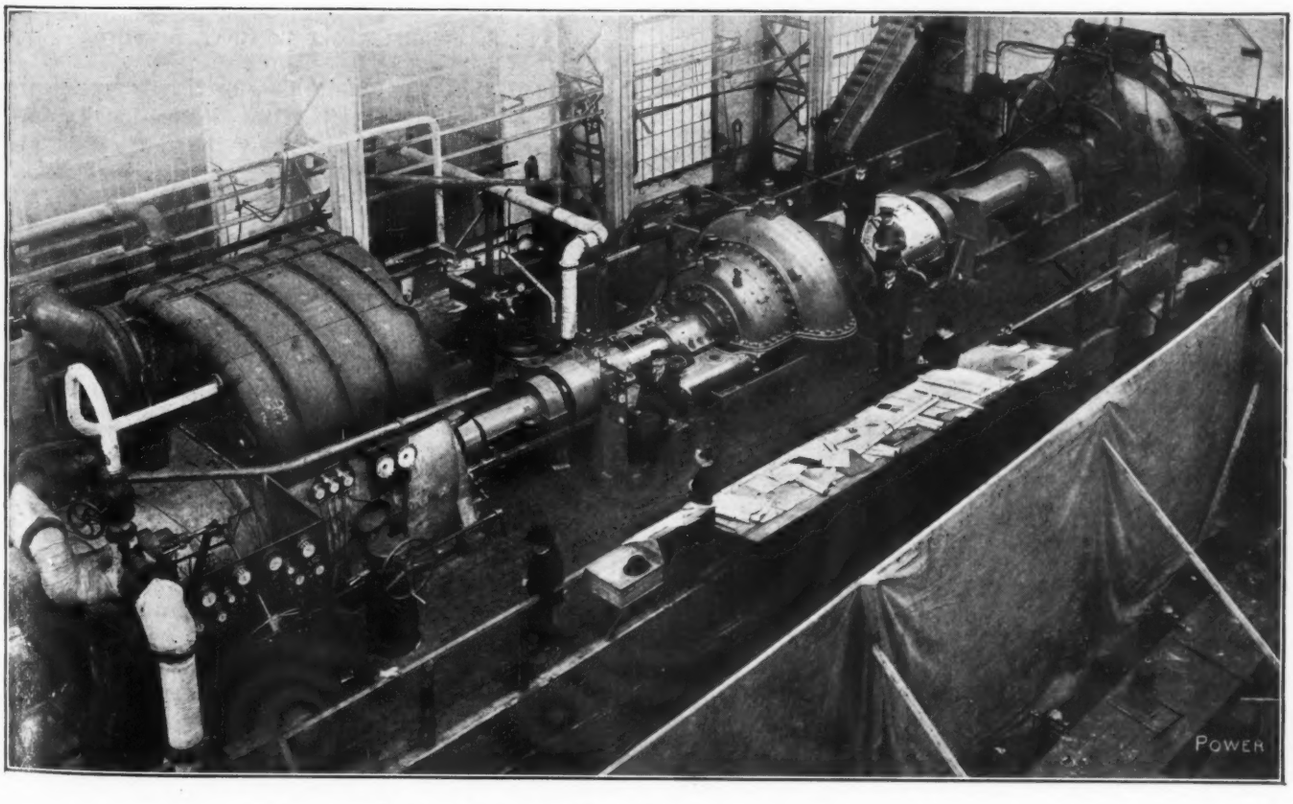


FIG. 3. TESTING TURBINE AND HYDRAULIC SPEED-REDUCTION GEAR

To confirm calculations, large units were frequently sacrificed for experimental purposes. Turbine parts, such as casings, some of very large dimensions, are put in a hydraulic press and the pressure increased until the steel castings crush, an engineer meanwhile observes, with the aid of instruments, the deflection of the castings.

Thorough care is exercised in choosing material. A large cast-steel turbine casing was deformed by Messrs.

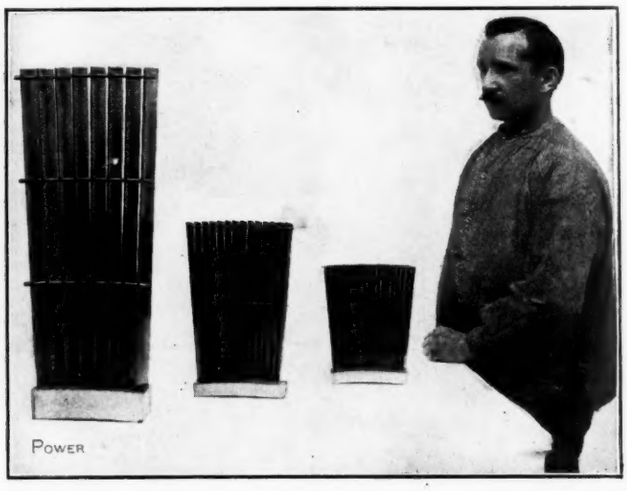


FIG. 4. BLADING OF LARGE LINER, SMALL LINER AND TORPEDO BOAT

Haniel & Lueg under a hydraulic press, to demonstrate the quality of the steel supplied for turbine casings.

The material intended for the blading is supplied in profile rods and is tested with special care, as slight defects in blade material may cause the most serious breakdowns at sea, when there are not adequate facilities for making proper repairs. Tests consist in gaging the form of cross-sections by means of the original patterns, having the profiled rods inspected by specially skilled workmen, ascertaining the breaking strength, tension, flexibility, surface hardness, etc.

Fig. 3 shows a 10,000-hp. turbine on the Hamburg work's test bed testing a Föttinger hydraulic speed-reducing gear.

pressure blades. The largest are reaction blades, and the smaller sets are action or impulse blades.

The turbines schematically represented in Figs. 5 to 7 are especially adapted for the driving of ship screws through hydraulic reduction gears, such as the Föttinger. Fig. 6 shows four low-pressure Curtis stages mounted on a common rotor. Fig. 7 shows separated nozzle systems for small and great outputs, respectively, instead of cruising stages inserted into the turbine.

Several of the turbine designs as shown may, of course, be connected up in parallel or series, as is especially desirable in the case of very large units, which cannot well be arranged in a single casing, or with turbine equipment for multiple-screw ship.

Though the management of the Vulcan works is of

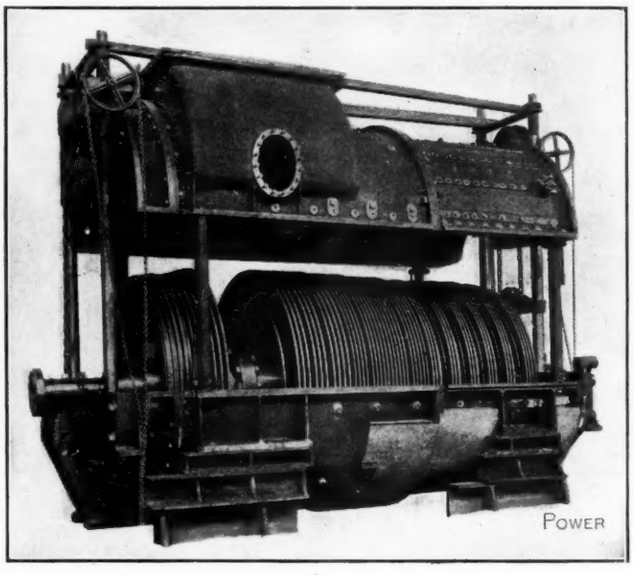


FIG. 8. TYPICAL TORPEDO BOAT TURBINE

the opinion that the use of turbines driving independently the various propeller shafts is the most rational means of ship propulsion, they will apply the Parsons series-connection principle, or, in fact, any other arrangement, to their own turbines when requested.

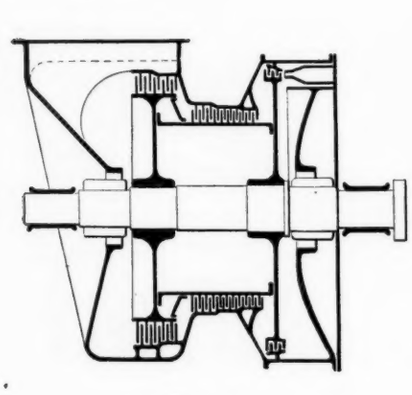


FIG. 5

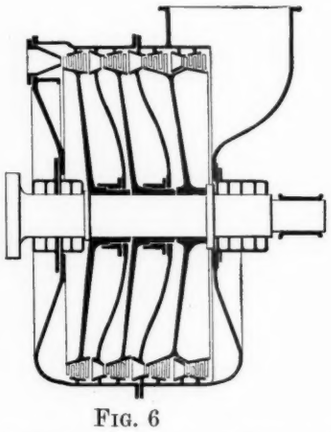


FIG. 6

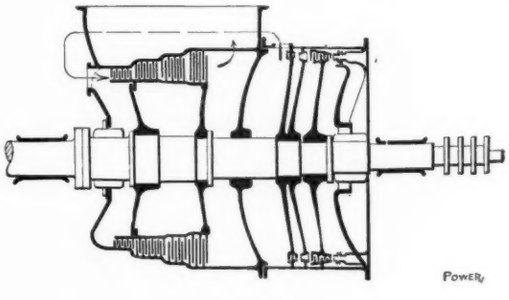


FIG. 7

SCHEMATIC ARRANGEMENT OF TURBINE WHEELS AND NOZZLES

The Vulcan ship turbines are designed on what is called a mixed system, that is to say, they are made up of one or more wheels bladed according to the action or reaction principle, or both. Fig. 4 shows some samples of low-

The turbine shown in Fig. 8 is representative of those used on torpedo boats. The Russian "catcher" "Novick" is driven by Vulcan turbines and is capable of making 37.6 knots per hour. She is the fastest vessel of her kind.

Outdoor Substations

Commenting on outdoor substations, in a paper presented at the midwinter convention of the American Institute of Electrical Engineers, Alexander Macomber says:

"The success attained during the past few years justifies the expectation that out-door substations will occupy an important part in the development of transmission work. Complete outdoor installations up to a few hundred kilovolt-amperes have enabled service to be given to isolated customers and small communities which otherwise could not be served profitably directly off the main transmission lines. The simplicity of design and construction has meant a small investment and a minimum of operating troubles. The high-tension switching is usually limited to air-break types, instead of the costly oil switches, while lightning protection is afforded either by the electrolytic lightning arrester or the cruder horn type. Most such installations have been free from elaborate secondary control, that provided being, if any, of the simplest type, placed in weatherproof housings.

"The application of the outdoor substation to large capacity installations, particularly where the secondary control is split up into various circuits with more or less auxiliary apparatus involves larger problems. With substations of this character, involving attendance, it is necessary to provide a suitable building designed for at least part of the installation. What part of the high-tension apparatus may properly be installed out of doors depends largely on the saving thereby effected. The actual outdoor apparatus must be provided for separately, and a combination of the indoor and outdoor substation will in many cases prove most advantageous. In some cases it is feasible to place the whole outfit out of doors, including the low-tension control equipment, provided the latter is not extensive, but in most cases it is questionable whether the operating features will permit this extreme. In cases where attendance is required it is certainly advisable to install the secondary equipment indoors.

Protective Equipment

"The most important protective apparatus affected by outdoor installation is the electrolytic lightning arrester. Heretofore, this equipment has been protected by housing, but the development of low-temperature electrolyte, and other details of design, makes it possible to place the apparatus out of doors, even under the most severe climatic conditions. The winter season, when the severest temperatures are encountered, is, as a rule, free from lightning disturbances, although it is important to secure continuous service of such protective devices on account of surges occurring on the lines. It is as much the function of the arrester to absorb these disturbances as to avert the direct effects of lightning.

Transformers

"The principal difficulty met with in connection with the transformers is the climatic changes. In general the outdoor transformer is similar to the indoor type, except that the cover and leads are designed to shed moisture and provide the necessary high factors of safety.

"Both self-cooled and water-cooled transformers are applicable to this service. With the former, grades of oil suited to the conditions are necessary. Usually the electrical load will keep the oil sufficiently warm, but precautions must be taken to prevent condensation of moisture. Sometimes this is accomplished by installing small heating coils in the upper part of the transformers. Freezing of the oil itself may be guarded against in idle units or under severe conditions, by external heating devices under the casings. Little trouble is experienced, however, as ordinary oil will not freeze at a temperature above —15 deg. C.

"The use of water-cooled transformers involves similar precautions against moisture, with the addition of protection to the water-circulating system, although the water due to its circulation probably would not freeze except under very severe conditions, provided the external connections are properly protected.

"There has been little experience with air-cooled transformers out of doors. It would seem that there might be a field for them as they do not offer the difficulties in providing climatic protection that are encountered with other types, provided moisture is kept out.

Control Apparatus

"Control apparatus, such as switches, circuit-breakers, etc., have met the severe conditions imposed and outdoor switches of high voltage are operating satisfactorily in severe sleet and snow storms."

Civil and Military Engineering at the Panama-Pacific International Exposition

Since the nations of the world will assemble war craft at Hampton Roads to proceed in a grand national pageant to the Panama-Pacific International Exposition in 1915, it is easy to understand the interest that is being taken in the display in the Palace of Liberal Arts, of the methods, processes and other phenomena of military and civil engineering, which is scheduled under group 40 in the department of liberal arts, the chief of which is Theodore Hardee.

Methods used in earthworks, in the construction of canals, railroads, levees and embankments will be prominent features of the exhibit in this connection, and municipal authorities, who promise to attend the exposition in great numbers, will be interested in the display of equipments for city sanitation. Methods employed in storing and distributing water will be given adequate representation, and for the military expert there will be provided full exhibits of various methods of defensive construction and engineering material employed in the operation of an army.

The contractor, builder, property owner and scientist will be interested in the exhibit of the methods employed in the testing of structural materials, the equipments and methods for the construction and maintenance of city, suburban and country roads. The methods and equipment for preparing foundations, including piles, pile-drivers, screw piles, caissons, wire trams, etc., will be shown in great variety.

Roadmaking is scheduled in group 41 of the exposition's classification of industries, and is embraced with the displays of inland navigation, the improvement of rivers, construction of canals, ship railways, reservoirs, pile sinkers, dredgers, sea port improvements, piers, docks, bridges, viaducts, maritime canals, protection against flooding by rivers or by the sea, elevated railways, tunnels and statistics, maps and other publications relative to public works and engineering societies.

Western Canada Power Co. to Increase Plant—The Western Canada Power Co., Vancouver, intends to add two 13,000-hp. hydro-electric generating units to its present plant. One of the new turbines will be installed next spring and the other early in 1915. The present plant of two units is capable of generating more than 25,000 hp. The additional plant and equipment of the new unit, including installation, will involve an expenditure of $500,000.

Gas-Producer Operation

By E. G. Moon

Among the important requirements of a producer gas for power purposes are that dust, soot, and tarry matter be removed, and that the temperature be lowered before the gas is delivered to the engine. The advantage of lowering the temperature is that the density of the gas is increased, so that a given volume can develop more power because it contains more heat units.

Installation

In setting up the producer care should be taken to facilitate the proper handling by raising it to such a level as will aid in cleaning and removing ashes and clinkers. If the producer is placed too close to the side walls, the operator will be hampered. Moreover, it must be in proper alignment and placed so as to avoid the use of unnecessary piping and fittings. Provision should be made for proper drainage from the scrubber, as the cleaning water is likely to gather considerable sulphur and tarry matter, which sometimes gives trouble in clogging and causes deterioration of the piping. After the producer has been set up on its foundation and aligned, the grates are put in place, and then the shell is lined with a good grade of firebrick.

The firebrick are usually of special shape, according to the construction of the producer. They should be carefully selected and any broken or cracked bricks discarded. It is well to order a few extra bricks, as more or less are broken in transit. Before placing the lining in the shell a template, as illustrated, should be made and laid out on the floor. In making this template allowance is made for an annular opening of at least 1 in. between the outside of the lining and the inside of the shell; this space is for insulation purposes. In fitting the brick to the template it is important that they fit each other closely, so as to not leave any openings or crevices between the brick greater than ⅛ in.

After the brick have been fitted to conform to the template, the laying of the lining may proceed. The mortar is made of a good grade of fireclay and water thoroughly mixed to the consistency of cement mortar. In placing the lining care must be exercised to make the joints smooth, as any irregularities or projections cause clinkers to adhere. As the operator uses the brick wall as a guide for the poking bar in scraping down the fine ash and clinker, the bar is apt to catch on projections and damage the lining.

After the fifth or sixth course of brick has been laid, the space between the lining and the shell should be filled in with a cement of asbestos and fireclay. This serves as a bottom for the insulation material, which usually consists of ordinary sand, although in some cases asbestos is used. The cement should be thoroughly tamped in to a depth of 12 or 14 in.; this prevents the sand from running out at the bottom. Further courses of firebrick are then laid, more sand is poured in and lightly tamped until within 3 or 4 in. from the top of the lining, the remaining space being filled in with asbestos and fireclay mortar.

If the producer is equipped with sight holes, corresponding openings in the brickwork must be provided. Pieces of iron pipe should be inserted through the sight holes, and the space around the pipe should be packed with asbestos and fireclay cement to prevent the sand from running out.

The lining having been completed, it should be looked over for cracks, and when found they should be filled in with a cement of asbestos and fireclay mixed to the consistency of putty. If the ordinary mixture of fireclay and water is used it will crumble and fall away on coming in contact with the fire.

The producer should now be cleaned out, after which it is ready for the cover to be bolted or riveted on. Next, the charging hopper and poke-hole covers are connected. Some producers have a bell-shaped casting to collect the gas from the center of the fuel bed which, of course, must be connected before placing the hopper in position. Where a mechanically operated poking bar is attached to a stationary connection inside the producer it must also be connected before putting the hopper in place.

Some producers have water jackets or superimposed vaporizers to supply the incoming air with vapor on its way to the fuel bed. Others use a small boiler between the producer and the scrubber; where boilers are already installed steam may be supplied from them. Also, in several installations heaters are connected in the exhaust pipe of the gas engine, the jacket water passing through to the vaporizer. The steam supply is controlled by the amount of water allowed to feed to the vaporizer.

Again, some installations use the exhaust gases from the engine for controlling the temperature of the fire in the producer.

Cleaning and Cooling Gas

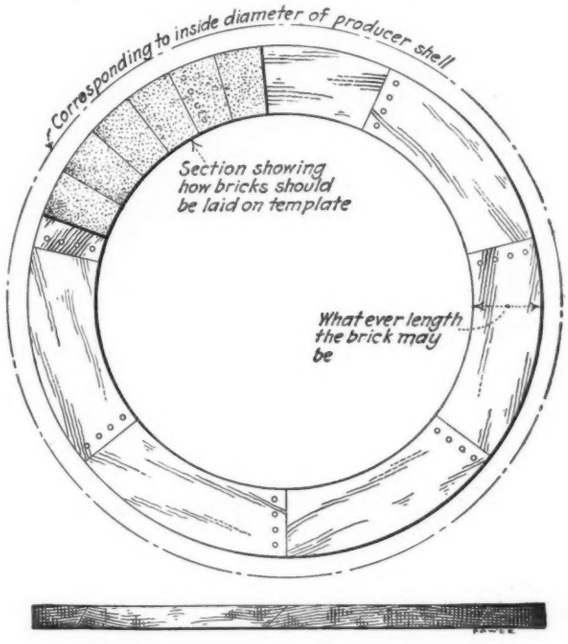
There are many types of scrubbers for cleaning and cooling the gas before it is delivered to the engine. Some consist of cast-iron shells sealed at the bottom and filled with wood slats, broken brick, charcoal, coke, or special cast-iron baffles. At the top of these scrubbers is attached a connection for cold water which flows down in a spray through the shell and comes in contact with the outgoing gases, thereby cleaning and cooling them. The water passes down into the water seal, then to the sewer or other outlet. The amount of water is so controlled as to allow enough to cool the gas to as nearly the surrounding temperature as possible. There are also mechanically operated scrubbers built to impart a centrifugal motion to the gases and at the same time inject cold water.

Some producers have a wet and a dry scrubber, the latter for further removing any tarry matter or dust that the wet scrubber fails to remove, but the principal reason for the dry scrubber is to separate any undue moisture that may be in the gas after leaving the wet scrubber. The many designs of dry scrubber consist essentially of a cylindrical shell filled with wood slats or excelsior and set in a water seal. Instead of a dry scrubber some installations employ a cylinder attached to the gas line between the wet scrubber and the engine; this is called a separator. The outlet from the gas line has a running nipple about one-third the length of the separator connected at the top and the gas outlet is also so con-

nected. If the gases contain any moisture, it will settle to the bottom of the separator and then pass out through a water seal.

Producers are generally provided with a purge pipe leading to the atmosphere. This pipe is to be opened when the apparatus is shut down, and closed when it is running. Some installations have fan blowers to create a draft when starting the producer; others employ natural draft through the purge pipe, while still others use a steam blower for this purpose. The latter method is possible where boilers are at hand. Still another arrangement consists of a special blower working on an air blast from the engine's starting tanks.

In connecting up the piping, fittings and various auxiliaries, precautions should be taken to see that they are thoroughly clean and free from scale on the inside.


Corresponding to inside diameter of producer shell
Section showing how bricks should be laid on template
Whatever length the brick may be

TEMPLATE FOR PRODUCER LINING

When connecting the scrubbers to the producer a very high heat-resisting packing should be used. All bolts, nuts and screwed pipe fittings should be coated with graphite and a good grade of oil, to facilitate taking them apart readily when repairs are necessary.

OPERATION

The producer and its auxiliaries having been installed and connected, the installation is made ready for service. All places where water seals are necessary should be filled with water; the gas valve leading to the engine should be closed and the valve on the purge pipe open. See that all the cleaning and ashpit doors are open; in some types the air inlet to the producer is closed and a blower is attached. Before building the fire, spread enough loose ashes over the grate and bottom of the producer to cover all metal work, then start a wood or soft-coal fire which will produce smoke and observe whether the joints are tight. If no leaks are noted, charge the producer with a small amount of coal and keep up a slow fire for several days to dry out the lining thoroughly; otherwise cracks are likely to occur. After the producer has been dried out it may be charged with coal to the required depth.

It is important that the fire burn evenly before filling the producer; then watch for any dead spots, as they form air holes and give trouble by permitting the air to pass through the fuel uncombined and thus dilute the gas. A try-cock or pilot light is usually connected to the outlet of the producer for ascertaining the quality of the gas. The trycock should be covered with a piece of wire gauze to prevent the flame from flashing back. A second purge pipe is connected to the gas line near the engine for freeing the line of air, as all the air should be expelled from the system before any flame comes near the outlet, otherwise an explosion may result. As soon as the gas burns freely at the pilot, the producer is ready for service.

The vent pipe at the engine should be closed, the air inlet at the bottom of the vaporizer opened, as well as that to the producer, and the purge pipe of the producer closed. Then turn on the water to the scrubber and the vaporizer, and as soon as the engine is started close the ashpit and cleaning doors.

The operator must not become discouraged if the producer does not at first respond according to his expectations; it may take several days before the proper adjustments are made to meet the conditions. One must become familiar with the required mixture of gas and air at the entrance, but this can only be determined by experience as different engines require different mixtures. Assuming that the engine is in good condition and properly adjusted, all that it needs is good gas; then the operator must turn his attention to the producer. He must watch the vaporizer and adjust it according to the instructions of the builder. The scrubber must also be watched to see if the gas is being delivered cold; if not, sufficient cold water should be turned in to cool the gas.

While the instructions may recommend poking the fire at certain intervals, it may be necessary to do this oftener, which will indicate that the producer is too small to carry the load. Some instructions say to clean the grate every 24 hr. and the ashpit once every other day, yet the writer knows of cases where the grate must be cleaned two or three times and the ashpit once or twice during the 24-hr. period.

Conditions in many plants cause a variance of operation as regards poking and cleaning; but conditions must be ascertained and judged by the operator himself.

It is essential to poke down the fine ash which accumulates on the walls; it is likely to fuse and form clinkers. When these form, the efficiency of the producer is greatly impaired as some of the incoming air will get by the clinker and materially weaken the gas; also, the poking down is hampered. Before poking down, the operator should remove the ashes from the edge of the grate so as to make room for those that are to be poked down from the walls of the lining. In cleaning the ashpit the door should not be open too long, as it may allow too much air to be drawn through the fuel bed. In taking out the ashes, remove just as much as will not disturb the clean portion of the fuel bed. This operation being disposed of, it is well to wait a few minutes before poking. Some producers are equipped with shaking grates.

In poking, a straight bar is used. The operator opens one poke hole at a time and bars down close to the wall of the producer, in a scraping fashion, to remove all

fine ash from the lining, keeping the poking bar as close to the lining as possible so as to scrape it clean. He will soon be able by feeling to distinguish the difference between the soft ash and the hard walls of the lining. Poking must be done quickly in some types of producers, as air is apt to be drawn in and weaken the gas. After the poking bar is removed the poke holes should be immediately closed and the operator proceed to the next one. When this is completed the grates may be cleaned again; that is, the edge of the grate. Of course, the second cleaning depends upon the condition of the fire. In cleaning the grate, be careful not to work the fire down too low as burning and warping of the grate and the metal work around it may result. The operator will learn by experience how often it will be necessary to flash the fire.

When seeking the depth of the fuel bed through the sight holes, precaution should be taken not to place the eye too near the hole as a flash of flame may cause a severe burn; a piece of glass or sheet mica against the hole will prevent this. In shutting down the plant, assuming the engine to be already shut down, open an ashpit door slightly, shut off the air inlets to the producer, the main valve on the gas line to the scrubber and the water supply to the scrubber; then open the purge valve just enough to maintain a proper draft during the standby period, while the producer is shut down. It is well to remove whatever thermometers that may be attached.

After the producer has been in operation some months trouble may be had in getting good gas. In such a case, see if the water is of the proper height in all water seals; look for clinkers, and if any are found regulate the vaporizer. If the producer is equipped with a thermostat this may be found corroded or perhaps the baffles or filling of the scrubber may need cleaning or renewing. Moreover, there may be leaks between the scrubber and the producer or leaks in the gas line itself, or possibly air holes in the fuel bed. If the producer is equipped with a tubular boiler, and the temperature of the water cannot be raised, the tubes may be covered with scales. If gas is not being delivered cold, the spray pipes and the scrubber may be corroded, or broken or split, thus causing the water to flow down the side of the shell, or the filling may need cleaning or renewing. If a centrifugal scrubber is employed, the vanes should be examined for deposits of tarry matter.

If the producer has been heavily taxed, the brick lining may become burned. All burned brick should be thrown away. Those not entirely burned out may be used for the upper courses and new brick supplied for the lower ones, but it is cheaper eventually to put in an entirely new lining.

The writer knows of several producer-gas plants now out of service, owing to abuse and overloading, brought about by employing inexperienced operators. In most of these cases the apparatus has been condemned and given up through no fault of its own. In many plants it is difficult to obtain skilled labor, and foreign labor is employed. If so, it is well to have a set of instructions got out in the language of the laborers and placed conspicuously in the producer room.

Spark-Gap Gage for High-Potential Testing

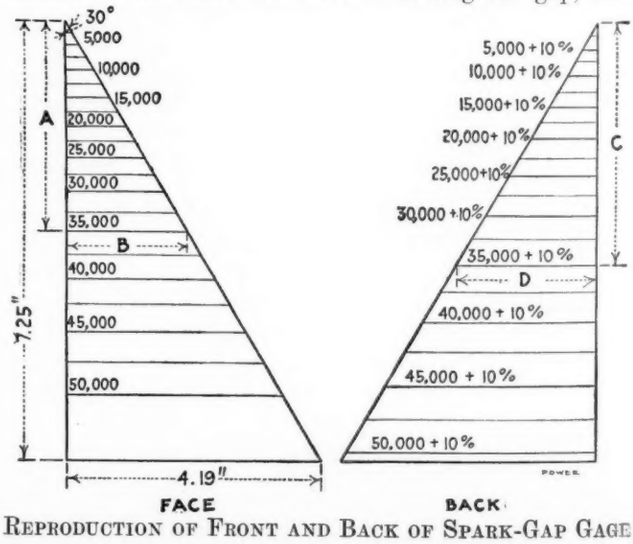
By H. M. Nichols

The usual practice when making high-potential tests is to have a spark gap in multiple with the testing circuit. The spark gap is usually set for a voltage 10 per cent. greater than the test voltage, and the voltmeter readings are depended upon for determining when the full voltage is obtained, the spark gap simply serving as an auxiliary protection. If greater accuracy is desired, the spark gap is first set for the exact test voltage and then the potential is gradually raised until the gap breaks down, notice being taken of the voltmeter readings just before this happens.

New needle points are next inserted and the gap is set for a 10 per cent. increase in voltage. The test is then made, the voltage being determined by setting the voltmeter to the same reading as was obtained just before the gap broke on the check test.

The usual way of setting the spark gap is to look up the number of inches, corresponding to the desired voltage, in a table on sparking distances, and then measure the distance between the two points. Where a large number of settings are made, as is the case in the commercial testing departments of large manufacturing concerns, the operation consumes considerable time. To save time and to insure greater accuracy, the gage shown in the sketch was devised.

While this gage was intended primarily for use in factory testing, it should prove of value to anyone who has much outside testing to do, as, for instance, the repair department of a large central station. An advantage of the device, other than the labor-saving feature, is that there is little chance for error in setting the gap, and



Reproduction of Front and Back of Spark-Gap Gage

consequently little danger of damage to the apparatus from applying excessive voltage.

TABLE OF DIMENSIONS FOR SPARK-GAP GAGE

Voltage	Front A, In.	B, In.	Back Voltage + 10%	C, In.	D, In.
2,500	0.19	0.112	2,500	0.22	0.124
5,000	0.39	0.225	5,000	0.43	0.25
7,500	0.61	0.35	7,500	0.66	0.38
10,000	0.81	0.47	10,000	0.88	0.51
12,500	1.04	0.60	12,500	1.14	0.66
15,000	1.25	0.72	15,000	1.40	0.81
17,500	1.49	0.86	17,500	1.65	0.95
20,000	1.73	1.00	20,000	1.92	1.11
22,500	1.98	1.14	22,500	2.24	1.29
25,000	2.25	1.30	25,000	2.53	1.46
27,500	2.52	1.46	27,500	2.84	1.64
30,000	2.81	1.62	30,000	3.18	1.84
32,500	3.14	1.81	32,500	3.58	2.07
35,000	3.46	2.00	35,000	4.01	2.32
37,500	3.85	2.22	37,500	4.45	2.57
40,000	4.25	2.45	40,000	4.94	2.85
42,500	4.67	2.70	42,500	5.47	3.16
45,000	5.11	2.95	45,000	6.03	3.49
47,500	5.64	3.25	47,500	6.58	3.80
50,000	6.15	3.55	50,000	7.10	4.10

The gage is made from a piece of flat steel, about ⅛ in. thick, ground to the dimensions shown, care being taken to have the edges straight and true, and the angle exactly 30 deg. One side of the gage is laid off for even voltages, and the opposite side for voltages 10 per cent. in excess of these voltages. The table gives the dimensions *A* to be used in laying off the lines on the gage corresponding to the various voltages. The dimensions *C* are used for laying off the back of the gage; while the dimensions *B* and *D* can be used to check the work of laying off the lines and to determine the accuracy of the gage.

The lines should be straight and true and cut deeply into the steel, so as to be easily seen. The figures should be stamped plainly and especially the 10 per cent. part in order to avoid the danger of some careless tester using the divisions on the back of the gage for those on its face.

A New Blowing Engine

Prior to the introduction of the gas engine, it was the general blowing-engine practice to limit the piston speed to 600 ft. per min., although cases were known where speeds of 800 ft. were employed.

To furnish the requisite amount of air for the blast furnace at such speeds as this required a ponderous and costly engine, and it was found desirable to increase the piston speed to 800 or 1000 ft. per min. to keep down the size of the engine. As a consequence, it was necessary to adopt some new design of blowing tub with much larger valve openings than formerly, so that the cylinder at the increased speed would be properly filled with air. To meet these requirements a new type of blowing engine has been designed by R. C. Holman. Its construction is shown in the accompanying illustrations.

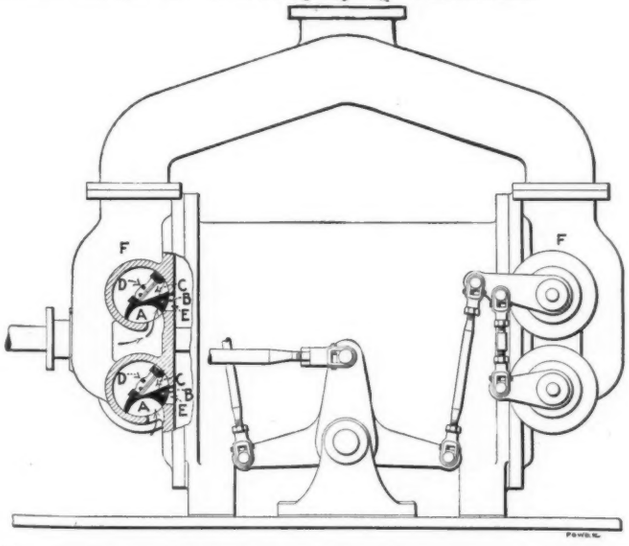


FIG. 1. INLET VALVE-GEAR SIDE, HORIZONTAL BLOWING CYLINDER

It is claimed by the designer that a blowing engine of the type shown can be built having inlet ports 25 per cent. of the area of the cylinder, and outlet ports 15 per cent. of the area of the cylinder, with a volumetric clearance of not over 1 per cent.

To remove both inlet and outlet valves from the cylinder it is necessary to take off the bonnet and withdraw the valve exactly as any Corliss valve is taken out. This valve contains all of the inaccessible parts of the air-distributing mechanism and will fit in any of the valve

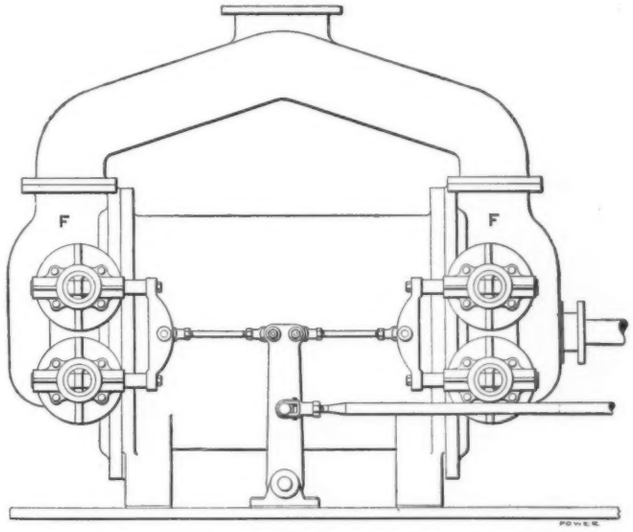


FIG. 2. OUTLET VALVE-GEAR SIDE OF CYLINDER

ports in the cylinder, provided that the ports are all bored alike. One complete valve in reserve then will provide a full set of repairs for all of the valves.

In the past, the use of flat gridiron and Corliss valves for compressors and blowing engines has not been attended with the best results, on account of the difficulty in properly lubricating the inlet valves. There is always enough oil pumped into the cylinder to properly lubricate the outlet valve, as the air leaving the cylinder is laden with oil. In the Holman machine the oil is pumped directly on the surface of the inlet valve at the edge of the port.

Fig. 1 shows the inlet valve-gear side of a horizontal blowing cylinder, and Fig. 2 the outlet valve-gear side. Fig. 3 is a section on the vertical center line through the cylinder and shows the valves in their proper relative position for the piston as shown. Fig. 4 is a section through the center of the valve and shows the outlet grid-

iron valve at the back of the inlet Corliss valve. Fig. 5 is a side view of a steam-driven blowing engine with the air cylinders behind the steam cylinder.

As will be apparent, the cuts show a steam-driven unit. The power is taken directly from the crankshaft and pin, while with a gas engine the valves are driven by eccentrics mounted on a layshaft, similar to the manner in which the inlet and outlet valves on the gas cylinder are driven.

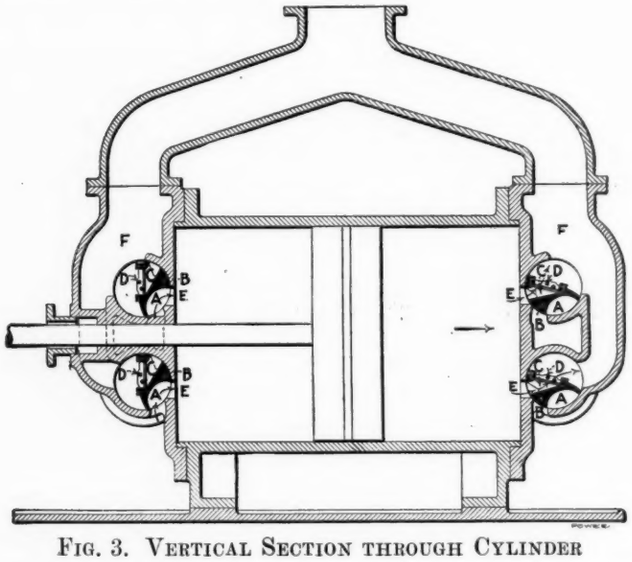


FIG. 3. VERTICAL SECTION THROUGH CYLINDER

Referring to Figs. 1, 3 and 4, *A* represents the inlet port through the inlet Corliss valve *B*, and *C* is the outlet port. The ports *E* in the cylinder head are alternately inlet and outlet ports, depending whether the piston is approaching or receding from the cylinder head. Each cylinder head contains two valves exactly alike, which are connected and work in unison. It is because both ports are used as inlet or outlet, as the requirements may be, that it is possible to secure such large openings with so small volumetric clearance.

The circular Corliss valve *B* of the sections shown in Figs. 1, 3 and 4 is given the proper oscillating motion by the valve-gear shown in Figs. 1 and 2, which is driven from the crankshaft in the case of a steam engine and from the layshaft of a gas engine. It is provided with the inlet and outlet passages referred to, and is fitted to a tee-headed valve stem *M* in the ordinary manner.

At one end of the outlet passage *C* through the valve *B* are cast a series of bars making gridiron openings through the valve, as in Fig. 4. The valve *B* is machined at this point to form a seat for the gridiron valve *D*, the openings through which correspond to the gridiron openings in the valve *B*. Rectangular ports *E* are cast in the cylinder head and act as inlet ports to the cylinder when the valves are in the position shown at the left of Fig. 3, and as outlet ports from the cylinder when the valves are in the position shown at the right of Fig. 3. At the center of the cylinder *F* is a passage connecting the discharge from each valve with the blast pipe. Fig. 4 is a horizontal section through *F*, and Fig. 1 is a section at one side of *F*. In Fig. 4, *G* are thrustwashers with a spring to hold the valve *B* from slapping back and forth with the movement of the gridiron valve *D*. In practice, however, these washers are only needed in starting, as the unbalanced pressure of the valve stem *M* is more than the friction of the gridiron valve *D*. A cam bar *H* gives motion to the crosshead *I*, which in turn operates the gridiron valve *D*, the thrustwashers *K* being used to transmit motion and at the same time allow the gridiron valve to oscillate with the Corliss valve *B*. The crosshead *I* does not oscillate, but has a sliding motion in the bonnet *L* from the cam bar *H*. At high rotative speeds it has been found preferable to substitute a link-driven mechanism for the cam on account of the liability of noise if the cams are not carefully fitted.

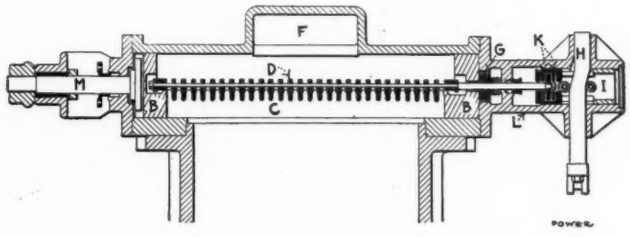


FIG. 4. SECTION THROUGH VALVE

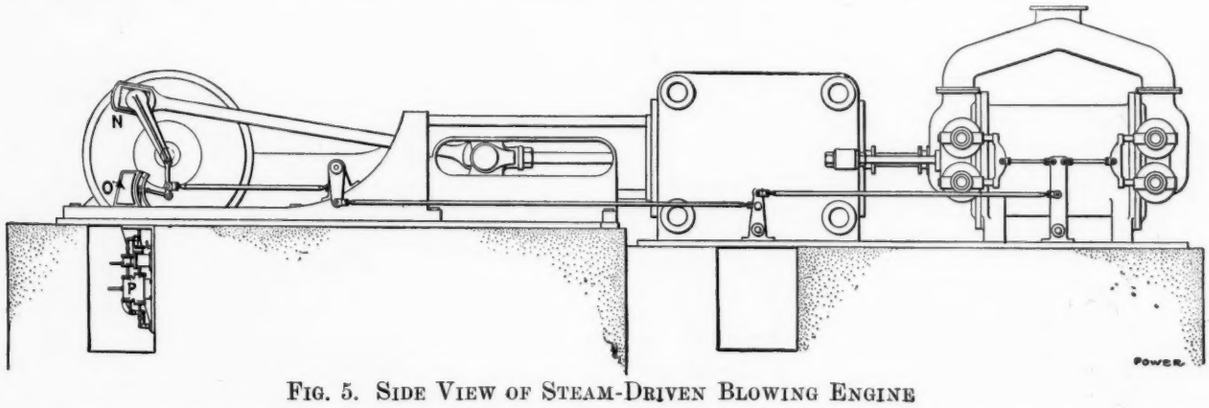


FIG. 5. SIDE VIEW OF STEAM-DRIVEN BLOWING ENGINE

The outlet driven mechanism is shown in Fig. 5, and consists of an arm keyed to the crankpin of the engine and set so that the pin at its end describes a circle. A quadrant *O* is fitted to the engine frame. In this quadrant slides a block to which is attached the link. The position of this block is governed by the piston in the relay oil cylinder *P*. The pressures in the blast pipe and blowing cylinder act upon a pilot valve which allows oil pressure to enter the actuating cylinder and so place the block in the quadrant that the outlet valve will open only when the pressure in the blowing cylinder is equal to that in the blast pipe. For example, if for some reason or other the blast pressure should suddenly drop,

the pilot valve would immediately move, due to the difference in pressure between that to which the air was being compressed and the blast pressure. This movement would allow oil pressure back of the actuating piston and change the position of the block in quadrant *O* to such a point that the outlet valve *D* would open when the compressed air in the cylinder would equal in pressure that in the blast pipe.

The actions of all the valves are positive. The time of opening and closing the inlet passage to the cylinder is determined by the Corliss valve *B* and is fixed; the inlet is opened when passage *A* is in communication with port *E*. The time of closing the discharge is determined by the Corliss valve *B* and is fixed. The time of opening the discharge is controlled by the discharge valve *D* and depends upon the pressure of air in the cylinder with relation to that in the blast pipe. There is never any possibility of the inlet and outlet ports being opened at the same time and the gas coming back from the blast furnace.

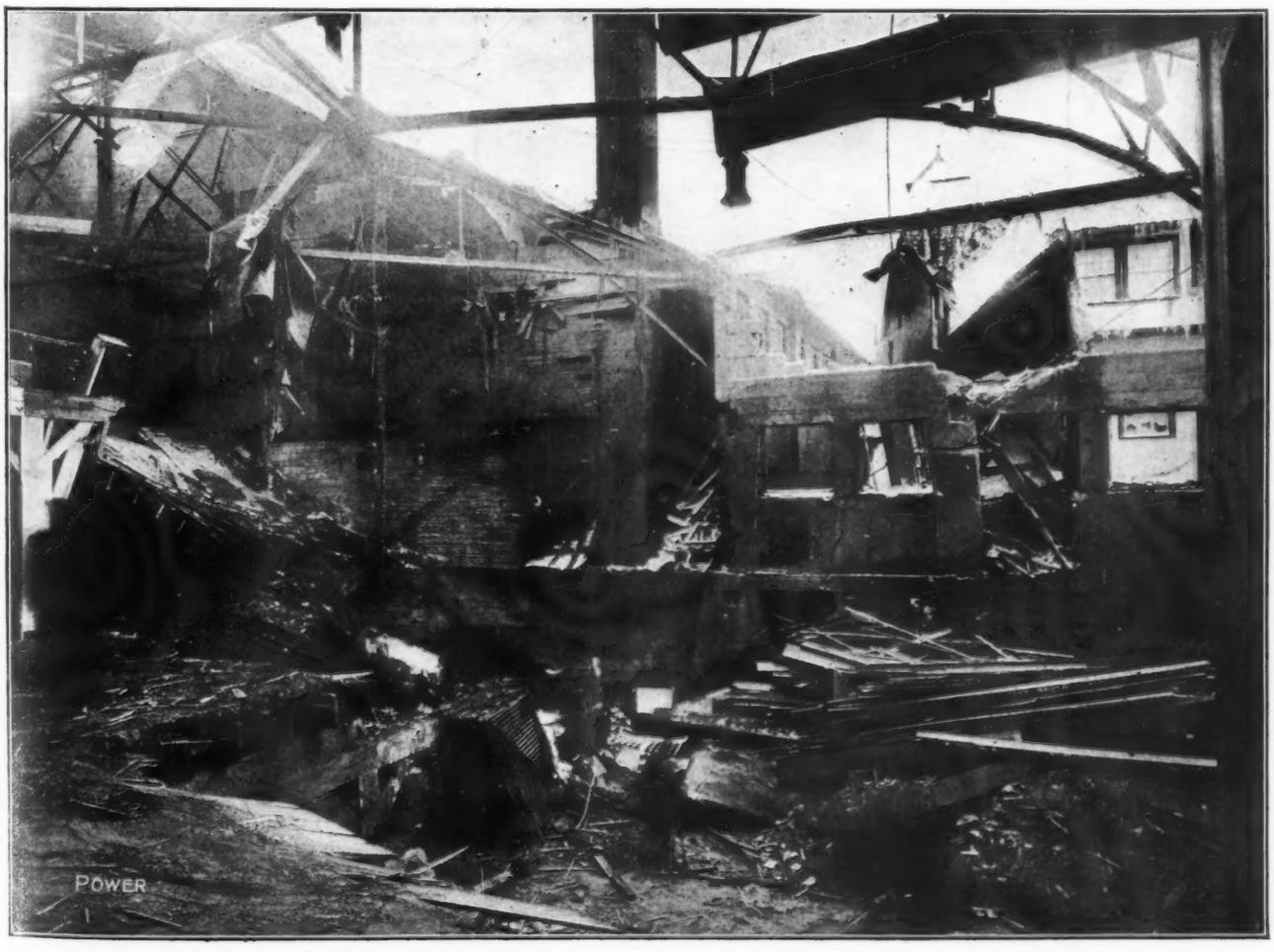
Boiler Explosion at Ottawa

A disastrous explosion of a return-tubular boiler occurred in the Fat Stock Building, at Howick Hall, Ottawa, Can., at 8 a.m., Jan. 21, killing three and injuring six. A cattle show was being held in the building.

The boiler, which was built in 1906 for a working pressure of 70 lb., was 60 in. by 14 ft. and had one girth seam only. The shell was $\frac{5}{16}$ in. thick and the heads $\frac{3}{8}$ in. thick; the boiler had 82 three-inch tubes. The girth seam was single riveted with $\frac{11}{16}$-in. rivets spaced at 2-in. centers. The longitudinal lap seam, when new, had a strength of 70 per cent. of the solid plate. The manhole had a cast-iron ring, which, at first, was thought the cause of the accident. The ring was split in two, but the rivets held. Most of the girth-seam rivets were sheared, although for a short distance the plate gave way.

There is considerable speculation as to the cause of the accident, but evidence produced at the inquest showed that the safety valve (of the ball-and-lever type) was not working properly, and that the boiler stop valve was only open $\frac{1}{16}$ of an inch; also that the pressure was on top of the disk.

Four different engineers have handled the boiler since it was installed, and they all appear to have set the safety valve to suit themselves. To remedy this state of



BOILER EXPLOSION AT OTTAWA

sealed pop valves, or that the inspector stamp on the boiler the allowable pressure.

Some idea of the force of the explosion can be gathered from the fact that a horse weighing over a ton was blown through the roof and landed 90 yards away. The total damage amounts to over $100,000.

Power-Plant Safety Devices

Various means have been adopted by different companies to guard against the accidental opening of the stop valve when a boiler is out of commission, and more particularly when there is anyone working in the boiler.

Perhaps one of the most effective means is that illustrated in Fig. 1, where *A* is a hinged metal case, painted red, which is slipped over the valve wheel and locked; *B* is a metal tag painted red with white letters. All the boilers are numbered both on the front and on the rear, and the valve is also numbered correspondingly with a metal plate, as shown at *C*. This avoids any possible confusion in operating or in locking the wrong valve. The right-hand view shows the casing locked over the valve wheel.

The position of stoker drive chains and sprocket wheels is frequently a menace to the men in the boiler room. In Fig. 4 is shown a method of safeguarding them, where the chain and the upper sprocket are encased by the plate shield *A* and the cast-iron shield *B*. The chain is oiled through the door *C*.

In Fig. 5 is shown the method of placing guards on a 1600-hp. motor rotor. The guards have a metal frame

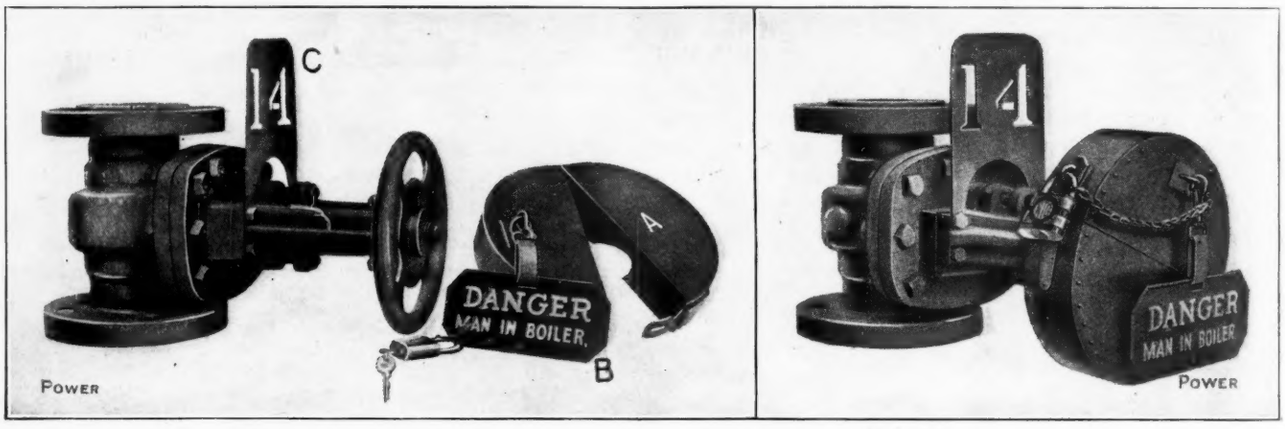


FIG. 1. OPEN AND CLOSED POSITION OF VALVE-WHEEL LOCKING DEVICE

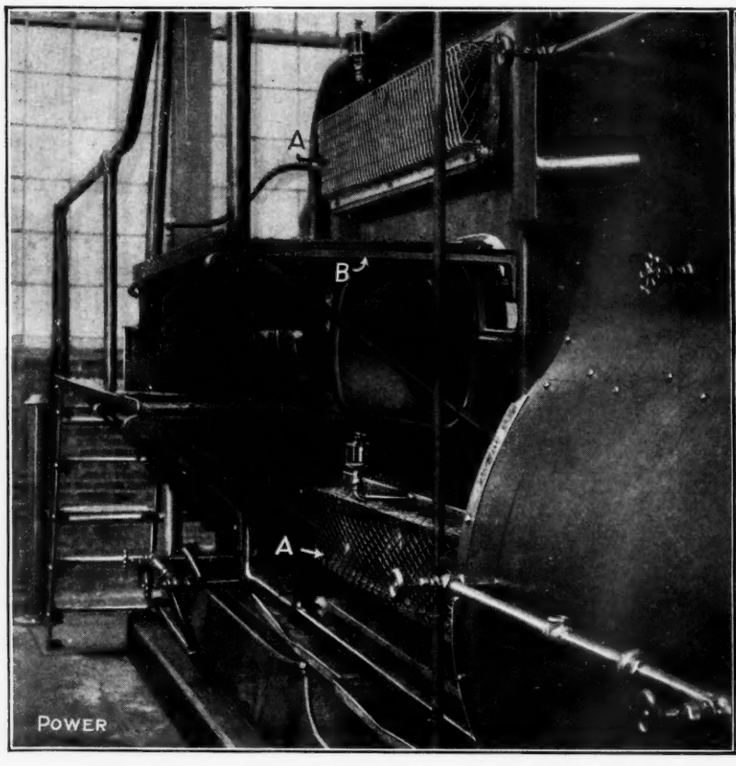


FIG. 2. GUARDS FOR PUMP CROSSHEADS

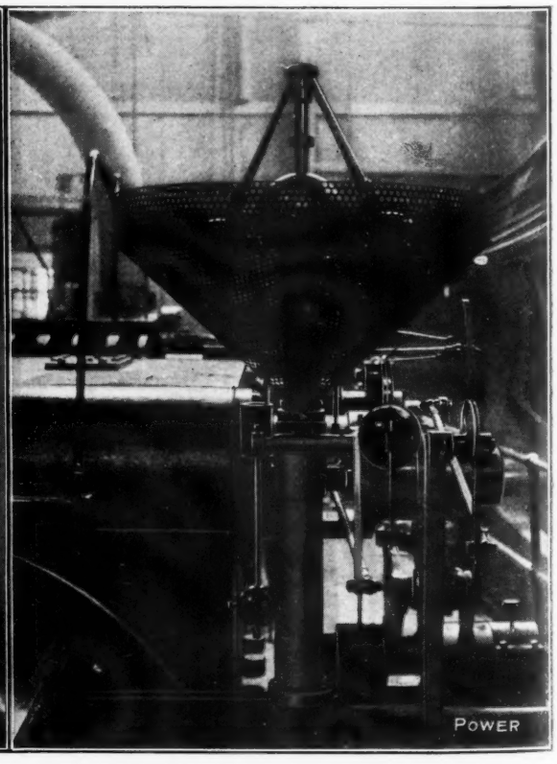


FIG. 3. PERFORATED GOVERNOR GUARD

to which wire netting is attached. The shields are hinged on the longest side to a metal upright, secured to the floor at one end and bolted to the motor frame at the other.

A method of guarding the flywheel governor of a roll-

guarding a governor is shown in Fig. 3, the guard being of perforated plate which is readily shaped and allows a view of the mechanism inside.

Placing a shield over the crosshead of engines is common practice and is advisable. In Fig. 3, at *A*, is shown

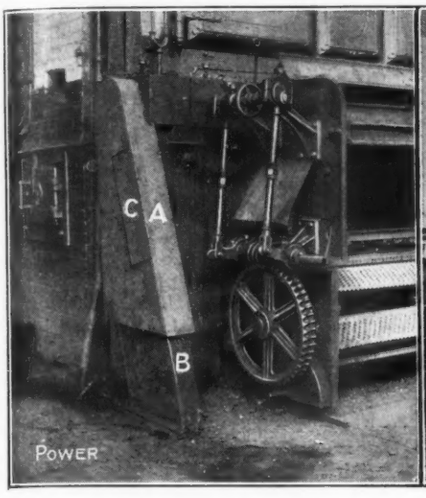


FIG. 4. STOKER-CHAIN AND SPROCKET SHIELD

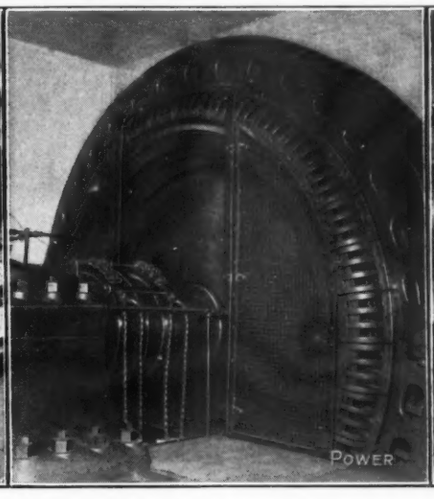


FIG. 5. GUARDS FOR MOTOR ROTOR

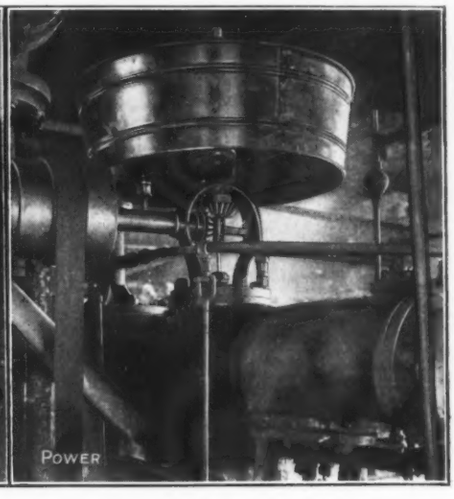


FIG. 6. SHEET-IRON GUARD FOR ENGINE GOVERNOR

ing-mill engine is shown in Fig. 6. The guard is secured to a metal cross-piece supported by the governor frame, and the shield is made of sheet iron. Another method of a means of guarding the crossheads of a pump. The oiling platform is at *B*. These safety devices are all used by the United States Steel Corporation.

Chimney Capacity for Burning Waste Fuels

BY DAVID MOFFAT MYERS

SYNOPSIS—The amount of air or oxygen required for the combustion of waste fuel depends upon its chemical composition, but the chimney capacity required depends on the character of the products of combustion. The required force of draft being known, the presence of moisture may add so much to the buoyancy of the escaping gases that the size of stack can, generally, be determined from the usual chimney formulas for burning coal.

To burn anthracite coal, about 12 lb. of air is chemically required for each pound of combustible, assuming that the combustible matter is all carbon. Since, in actual boiler practice, 50 to 100 per cent. more air is added to permit of more perfect mixing of the fuel gases with the oxygen, the assumption of 12 lb. of air per pound of anthracite coal is close enough for all practical purposes.

Waste fuels of a woody or fibrous nature vary so greatly from the composition of coal that the question of air supply requires special consideration. Spent hemlock tan bark is such a fuel and as it is quite extensively used for making steam, consideration of the requirements for its combustion may be of interest.

Dried samples of average tan bark yield the following analysis within 1 per cent:

Carbon	0.52
Hydrogen	0.06
Oxygen	0.41
Ash	0.01
	1.00

The atomic weights of the elements concerned being H = 1, C = 12 and O = 16, assuming that the carbon burns to carbonic-acid gas, or CO_2, and the hydrogen to superheated steam or H_2O, the oxygen required is:

For the carbon

$$C + O_2 = CO_2, \text{ or } 12 + 32 = 44$$

i.e., the carbon requires $\frac{32}{12} = 2\frac{2}{3}$ times its weight of oxygen. As air by weight contains about 23 parts oxygen and 77 parts nitrogen, the air required will be $\frac{100}{23}$ times the oxygen required; for the carbon $\frac{100}{23} \times 2\frac{2}{3} = 11.6$ (say 12) times the weight of the carbon. So that to burn the carbon each pound of dry tan bark must be provided with about $12 \times 0.52 = 6.25$ lb. of air.

For the hydrogen

$$H_2 + O = H_2O \text{ or } 2 + 16 = 18$$

i.e., the hydrogen requires $\frac{16}{2} = 8$ times its own weight of oxygen, and the air required will be

$$8 \times \frac{100}{23} = 34.8$$

say, 35 times the weight of the hydrogen. Hence combustion of the hydrogen in a pound of dry tan bark requires about

$$35 \times 0.06 = 2.10 \textit{ lb. of air.}$$

It is to be seen, therefore, that the combustible ingredients require for combustion, per pound of dry fuel,

$$6.25 + 2.10 = 8.35 \textit{ lb. of air.}$$

But the fuel itself contains 0.41 lb. of oxygen, which is

equivalent to as much oxygen as would be obtained from $\frac{100}{23} \times 0.41 = 1.78$ lb. of air, so that the net chemical requirement of air will be

$$8.35 - 1.78 = 6.57 \text{ lb.}$$

of air per lb. of the dry fuel, or, only a little over half the air required per pound of anthracite coal.

But with tank bark each dry pound of the material as fired carries with it about 2 lb. of moisture, which being evaporated in the furnace, must be carried off by the chimney as superheated steam. This addition to the products of combustion occurs, however, after the draft has entered the furnace so that the presence of moisture while requiring no additional air supply requires additional chimney capacity for carrying off the steam thus generated and with induced draft, the duty of the fan would include handling the steam thus formed.

In designing a chimney for any fuel, attention should be directed first to the height required to obtain proper penetration of the fuel bed by the necessary air supply, as the rate of combustion is mainly controlled by the intensity of the draft, the latter being proportional to the square root of the height of the stack.

In the author's experience the best results in burning tan bark are obtained with a draft of 0.45 to 0.5 in. of water and the temperature of chimney gases is found to be sufficient to create this draft with a stack 150 ft. high. Having decided on a suitable height of chimney, the rate of combustion and the resistance of the fuel bed and draft passages, the diameter or cross-sectional area of the chimney may be found by applying Kent's chimney formula for burning coal, which is:

$$\textit{boiler horsepower of chimney} = 3.33 \times E\sqrt{H}$$

in which

E = Effective area of stack in square feet;

H = Height of stack in feet.

This formula, which is founded on practice, is based on the consumption of 5 lb. of coal per hp. per hr. to allow for poor combustion, for a large excess of air supply and for forcing the boiler beyond its rated capacity. In using it the heat value of the fuel employed as compared with coal must be taken into account.

According to the analysis, burning 1 lb. of dry tan bark (3 lb. of wet tan bark) would yield 7950 B.t.u., whereas 1 lb. of dry coal gives about 14,000 B.t.u.* Therefore, to generate the same horsepower as 5 lb. of coal, there must be burned

$$\frac{5 \times 14{,}000}{7950} = 8.8 \textit{ lb. of dry tan bark}$$

or 26.4 lb. of wet tank bark.

With fair combustion, 100 per cent. excess air may be considered as requisite for either tan bark or coal, and for 1 lb. of each fuel we have their respective air requirements and their consequent products of combustion measured by weight.

From the foregoing it is to be seen that the weight of the products of combustion of tan bark, i.e., of 1 lb. dry tan = 3 lb. wet, would be:

From dry tan burned	1.00 lb.
From moisture evaporated	2.00 lb.
From air chemically required	6.57 lb.
From 100 per cent. excess air	6.57 lb.
Total per dry lb. or per 3 lb. wet tan	16.14 lb.

*See author's paper "Tan Bark as a Boiler Fuel," Transactions of the American Society of Mechanical Engineers, Vol. 31 (1909), page 685.

and the products of combustion for 26.4 lb. wet tan bark would be 142.03 lb.

The weights of the products of combustion of 1 lb. of coal would be:

From coal	1 lb.
From air chemically required	12 lb.
From 100 per cent. excess air	12 lb.
Total products of combustion for 1 lb. of coal	25 lb.

and the total products of combustion for 5 lb. of coal would be 125 lb.

Owing to the liberal proportions of chimney derivable from Kent's formula, the writer has known stacks for burning coal to work satisfactorily at 50 and even 100 per cent. over capacities as rated by that formula. In burning wet chips, tan bark and sawdust, the writer has also found that when the stack height is properly proportioned for the fuel and for the local governing conditions, its size for a given horsepower capacity may be calculated directly by that formula. Although the total weight of the products of combustion of tan bark is greater than from the combustion of the equivalent coal, as has been shown, the moisture alone causes the greater weight. Moisture evaporated from the wet fuel makes a lighter column of hot gas in the chimney than would be made if dry coal were burned. Since the capacity of a chimney increases as its contained column of gases is lighter, a compensating effect takes place when a wet fuel is burned.

As the specific density of superheated steam is 0.622 as compared to 1 for air, if the chimney gases in the coal-burning example be considered to have the same specific volume as air, an idea can be obtained of the effect of the moisture evaporated from the tan bark both on the force of draft and the capacity of the stack.

From the first table quoted the moisture or superheated steam constitutes $\frac{2.00}{16.14}$, or about 12.4 per cent. of the total weight of chimney gases. Hence, the weight may be taken as

$$12.4 \times 0.622 = 7.7 \textit{ per cent.}$$

for the contained superheated steam and

$$\frac{16.14 - 2}{16.14} = 87.6 \textit{ per cent.}$$

for the remaining products.

The column of hot chimney gas from the tan bark therefore is about 5 per cent. lighter than that produced by the coal and, the temperatures being the same, the intensity of draft would be about 5 per cent. greater, but the velocity of the gases and consequently the volume of gases discharged by the stack would be increased only to the extent of $\sqrt{\frac{100}{95}}$ or about 2½ per cent.

The foregoing leads us to the following conclusions:

1. Stack capacity for a waste fuel depends upon its chemical composition, and upon its degree of contained moisture.

2. The element of moisture in the fuel does not affect the capacity of a fan blower for undergrate draft; but it does affect the calculation of fan capacity for an induced-draft system.

3. Although a pound of the waste fuel may chemically require only one-half the air required by a pound of coal, the chimney gases resulting from its actual combustion may be greater in amount than those produced by burning an amount of coal having the heat equivalent.

4. In designing a chimney, careful distinction must

be observed between required intensity of draft, which is proportional to the height of the chimney, and capacity or volume of draft, which is directly proportional to the effective area but increases only as the square root of the height; and that it is important first to determine the height of the stack in accordance with the nature of the fuel and the rate of its combustion. After this the diameter or cross-section may properly be calculated from the chimney formula with due consideration for the volume and weight of the gases.

5. A fuel of the composition of tan bark will require more or less chimney capacity than coal, depending upon its percentage of moisture content.

6. Moisture in chimney gases tends to decrease their density, but in some cases it may increase the capacity of the stack, and thereby compensate for its presence.

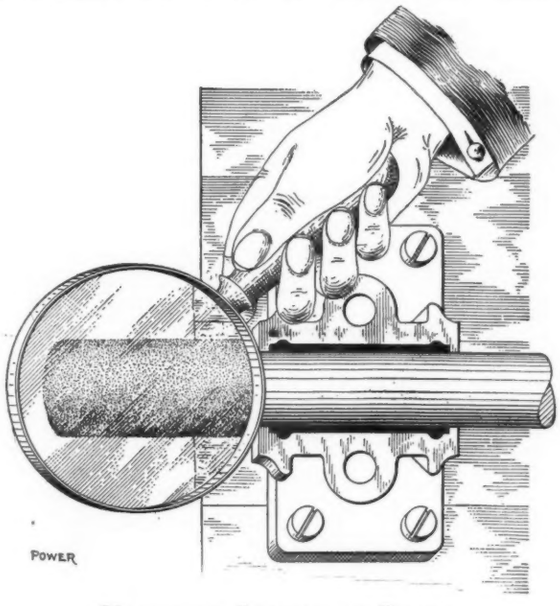
Bearing Metal Manufacturing and Use

By L. D. Allen*

SYNOPSIS—Cause and cost of friction Characteristics and classification of metals used for bearings. Requirements in the manufacture of bearing alloys.

"It is not work that kills men, it is worry." It is not motion that destroys machinery, it is friction.

Friction, a destructive agent, constantly piling up waste and expense, is everywhere. And yet, of the many details connected with the operation and care of machinery,



Magnified Section of Shaft

it is doubtful if any receive less attention than the reduction of friction. In many installations the shafting alone requires from 20 to 30 per cent. of the power developed by the engine and in some cases these figures are probably greatly exceeded. Comparatively few realize the significance of these figures, which mean that of every ton of fuel consumed some 400 lb. or more are wasted in overcoming friction. Much of such waste can be greatly reduced, but in the rush of getting out work such as prevails in many mills and factories, few, if any, have the time and patience to go into details and correct bad conditions. The prevailing idea seems to be that greatest economy will be effected by buying at a low price rather than by securing efficiency and reduction in wear through the use of suitable material and methods.

*Antifriction specialist, Chicago, Ill.

Power lost through friction is converted into heat which under normal conditions is radiated as fast as produced, the bearing surfaces remaining at or near the temperature of the surrounding air. If the heat is generated faster than it is dissipated, a hot or fused bearing will result. For this reason the antifrictional properties of a bearing metal are more desirable than tensile and compression strength. Many judge a metal by its compression strength and its tin content, whereas, under high speed, metals high in tin are usually the first to heat and fuse. It makes no difference how much tin a metal contains, how hard it is or how great its compression strength, if it heats it will soon fuse and run out of the bearing and under such conditions it is no better than so much lead.

Cause and Cost of Friction

Resistance to motion, friction, is great or small according to the roughness or unevenness of the surfaces in moving contact. In reality there are no absolutely smooth metal surfaces. A surface may seem smooth to the touch, but by means of a powerful lens, minute projections, roughness and unevenness may be seen, as illustrated herewith, which create the resistance. By proper lubrication a film of lubricant is established and maintained between the rubbing surfaces which tends to prevent the irregularities from meshing. The conditions for this film are favorable only to such extent as the bearing and shaft are smooth.

To a greater extent than most people realize the "cost of the babbitt or the lubricant is the cost of the friction accompanying the same."

A concern may spend several dollars less per hundred pounds for a babbitt that will show apparently satisfactory wear, but the question is how much money does this concern spend on other things as a result of the friction developed from the use of this particular babbitt. It may not even heat in a slow-running bearing, but if it is low in antifrictional qualities it communicates to the other parts of the machinery a certain amount of pull and drag and this percentage, even though small in any one bearing, develops to considerable proportions in the aggregate friction of all the bearings throughout a plant.

Babbitt Requirements

The requirements of a babbitt are: First, that it be composed of metals least susceptible to frictional contact; second, that it possess the sustaining properties necessary

to carry the load imposed; third, that the ingredients be so treated, reduced and combined as to produce an even, smooth, unctuous surface, which will minimize interlocking, abrasion and friction in its various forms.

The metals used in the manufacture of the various babbitts, type metals, solders, etc., are two or more of the following: Tin, lead, copper, antimony and bismuth. Some idea of the bearing value of these different metals may be derived from the properties of each as enumerated herewith.

Properties of Tin

Tin is a white metal with a yellowish tinge. It toughens the alloy, lowers the melting point and assists in producing a strong, homogeneous mixture. It is a "dry" metal, that is, somewhat lacking in antifrictional properties. Under heavy friction it heats quickly and fuses. Over direct heat it melts at about 450 deg. F.; its specific gravity is 7.35. The grade generally used in the manufacture of babbitt metals is known as Straits tin. There are now in this country a number of detinning concerns which are producing a nearly pure tin by either a chemical or sweating process from old scrap, tin cans, etc. This is now being used extensively in the manufacture of babbitts and cheap solders, as it can be bought at about a cent per pound under the market price.

Lead

Lead is another ore product and imparts softness, lowers the melting point and reduces the tendency to heat. It reduces friction more than any other metal, resembling graphite in this respect. It melts over direct heat at about 620 deg. F., and its specific gravity is 11.38. In many sections considerable antimony ore is found combined with the lead ore, so that in the process of refining the lead a slag or byproduct results, which is known as antimonial lead. This is put through a further refining process, which does not separate the lead from the antimony, but removes considerable of the impurities such as iron, arsenic, etc. The resultant product usually contains anywhere from 12 to 22 per cent. antimony, the rest being lead and some impurities. This antimonial lead is used in making cheap babbitts, type metals, casting metals, etc., for competition where a low price is necessary.

Copper

Copper hardens and toughens the alloy and raises the melting point. It slightly increases friction. It melts at a temperature of 1943 deg. F., and its specific gravity is 8.85. Copper is the basis metal in bronze, brasses, etc. Very little of it is used in babbitt metal, from 0.25 to 0.5 per cent. in a lead-based babbitt, although there are some mixtures that contain as much as 10 per cent. copper, the hard babbitt, for instance, known as "Hard Genuine," containing 80 lb. of tin, 10 lb. of antimony and 10 lb. of copper. Copper and lead are not particularly fond of each other. The writer does not care for copper in a lead-based babbitt; it hardens the babbitt somewhat, but it reduces the antifrictional value.

Antimony

Antimony is an imported ore product. It is a hard, brittle, bluish-white metal of crystalline structure. It hardens an alloy and raises the melting point. It is a great reducer of heat and it also reduces friction. It melts over direct heat at about 1169 deg. F., and its specific gravity is. 6.76. The crystalline grain or fracture in a babbitt is due to its antimony content. Some very carefully and scientifically conducted tests indicate that the best babbitts should not contain over 13 per cent. antimony, as the evenness of the alloy and its wearing qualities are greatest at that point.

Bismuth

Bismuth reduces friction and prevents shrinkage. It lowers the melting point and expands on cooling. It melts at a temperature of about 507 deg. F., and its specific gravity is 9.82. As bismuth usually costs more than $2 per pound, it is not at all popular with the babbitt manufacturer.

Aluminum

Aluminum is rarely used in a babbitt. It imparts some toughness by closing the grain and acts as a flux. It slightly increases the friction which offsets its toughening properties and makes it of no practical value in a babbitt.

Certain combinations of tin, copper and antimony shrink on cooling. Tin and lead alone shrink slightly and antimony remains about constant. Any two metals mixed together in the form of an alloy produce a metal which melts at a lower temperature than the original metal having the higher melting point and in some cases, lower than the metal with the lower melting point.

Classification of Bearing Metals

Bearing metals or linings may be classified under two heads, babbitt metals, which are largely tin, lead, antimony and sometimes copper compositions, and brasses and bronzes, which are tin, copper and zinc compositions, sometimes containing certain percentages of lead.

Babbitts range in composition from a cheap metal containing 90 lb. lead and 10 lb. antimony, to mixtures containing about 88 lb. tin, 4 lb. copper and 8 lb. antimony.

Babbitt metals are divided into three classes, the lead-based antifriction metals, which are metals in which the lead content is the heaviest, the smaller percentages being tin and antimony; the semi-tin-based metals in which the tin and lead contents are about equal, leaving room for from 10 to 20 per cent. antimony, and the tin-based metals, which range from 75 lb. up to 90 lb. of tin in each 100 lb.

I have knowledge of over 200 different babbitt mixtures that are in actual use, whereas only about seven or eight are really necessary. Babbitt metals should be made according to certain exact percentages, or so constructed as to be evenly balanced, so as to produce perfectly homogeneous mixtures or alloys, in order that a combination may possess its maximum strength and hardness.

Bearing-Metal Manufacturers

There are four kinds of bearing- and type-metal manufacturers.

The first is the smelterer who buys and refines drosses, scrap metals, etc., and converts the resultant product into different grade of babbitt metals, type metals, solders, etc. He sells to a large trade, which is influenced or attracted by a low price; its requirements are large in the matter of quantity, but not exacting in the matter of quality.

The second, is the man who installs a kettle, buys tin, lead and antimony and mixes them in certain proportions

according to some one or set of published formulas. Not only are these published or analytical formulas, as a rule, incorrect, but they have very little to do with the details of producing the right kind of finished product. The amount of business he does is in proportion to his luck and hustle.

The third is a combination of the two foregoing classes.

The fourth is the experienced alloyist who has studied the properties of all the different metals, so that he knows which will combine best and how best to combine them—the best temperatures and fluxes to employ, etc. He has also, to combine with the foregoing data, a practical knowledge of the uses to which the metals are put. This type of man gets the discriminating, careful trade, which makes a thorough study and test of its needs and demands results accordingly, or which, in buying, places quality first.

Manufacturing Requirements

Many years of practical experience with the formulas and manufacturing methods employed by different babbitt manufacturers both in the United States and abroad, coupled with deductions from results shown by expert analytical and mechanical tests and under actual working conditions in nearly all kinds of machinery, indicate conclusively the following facts:

The best amalgams are produced by the alloying method. This requires the use of several furnaces, pure materials, and consists in making up, at suitable temperatures, certain primary combinations of affinity metals; then taking such quantity of each combination as is necessary to produce the required grade and alloying the same under suitable temperature into the finished product. Metals may be well mixed but the quality and permanency of the mixture are determined by just such solubility laws as control ordinary solutions. Certain perfect amalgams at high temperature become partly separated amalgams at low temperature; others there are that remain perfect amalgams at any temperature.

In the use of the lead-antimony and the lead-antimony-tin mixtures a complete reduction of the crystal formation is important to insure smooth mirror-like nonabrasive bearing surfaces. All the ingredients must be evenly balanced and distributed throughout the alloy. It is for this reason that a lengthy annealing period is desirable because it has been found to have a greater effect on the mechanical properties of a metal than the temperature factor.

The tin, copper, zinc, aluminum, nickel, etc., amalgams are the most difficult to produce. They require skill and care in the introduction of deoxidizing agents, such as magnesium, phosphorus, silicon, etc.

Virgin vs. Old Metal

Very often large babbitt users who have their own formulas specify that "virgin" metal be used. Metallurgists claim that it is not a question of whether virgin metal or old metal be used so long as the metal is "pure," free from dissolved or mechanically entangled oxides. It is the oxides and impurities that impair repeatedly overheated or remelted metals. Some good authorities claim that the dross of tin, lead and antimony products (when free from iron, aluminum, zinc and arsenic) and smelted in an adequate reducing furnace at above 2500 deg. F., will, with the proper additions made to the resultant metal, produce amalgams that are superior to the same amalgams made from all virgin metals because the amalgams will be better alloyed than when virgin metal is used. My experience, however, leads me to doubt this and to believe that chemically pure, perfectly balanced amalgams made of virgin metal produce the surest and strongest babbitt metals made and that they possess higher antifrictional properties.

Chemical Analysis Alone No Guide

A babbitt should not be selected on analysis, as there is much that enters into the making of the metal and that has to do with its physical properties that evades the chemists. Nor should one babbitt be selected for all bearing requirements. Metals heavy in lead are best antifrictionally when properly alloyed, but metals heavy in tin and copper are also desirable where toughness combined with hardness is required to meet unusually severe or irregular bearing conditions.

Considering the price of lead and antimony, there is no legitimate reason for paying 18c. to 25c. per pound for bluish-looking or leady-looking metal, the tin content of which is usually not over 15 per cent. and often below 10 per cent. On the other hand, considering the high price of tin, no one should expect to pay much, if any, below the market price of tin for the whitish-looking or tin-based metals, or a medium figure for the semi-tin-based metals which are also white in appearance.

Babbitt troubles are often due to a good many things other than the babbitt itself. Some of these things are a selection of the wrong grade of metal; the wrong application of the metal; irregular bearing conditions; bad lubrication; neglect, etc.

The safest course for the purchaser who wishes to secure the best bearing values is to place his babbitt orders with such manufacturers only as are thoroughly experienced in bearing requirements, who know just what metals or combinations of metals possess the best endurance and antifrictional properties, who are also thoroughly skilled in alloying and combining metals, and, as well, honest and conscientious in their trade relations.

Prices and analyses are usually dangerous factors to rely upon in the selection of a babbitt. The size of the bearing, the thickness of the lining and the speed and load conditions should influence the choice. A properly made, hardened and strengthened lead-based babbitt will, oft-times, due to its naturally better antifrictional properties, give better service than an expensive tin-based metal.

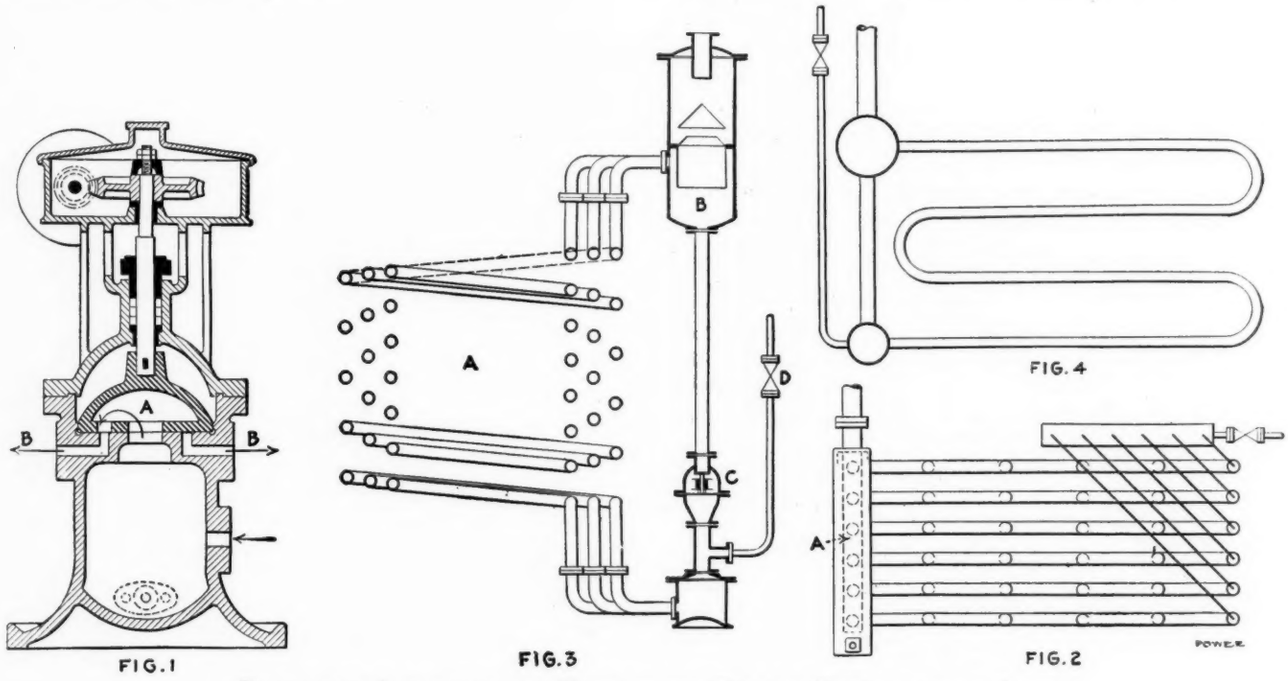
San Diego Exposition—The many exhibitors and concessionaries at the San Diego Exposition have been notified that all buildings for exhibits or concessions must be ready for installation by July 1, 1914. Four of the big exhibitors are working on the grounds, and some of the concessions have been begun. Another month will see the completion of the great reinforced viaduct over Cabrillo cañon, at the west entrance to the exposition, permitting the hauling of material for the remainder of the construction work over a much shorter and easier route, and giving easy access to visitors to the grounds. The exposition work is now nine weeks ahead of schedule and the plantations and ground work are 85 per cent. complete. Commissioners are now scattered over the United States, Europe and Central and South America, securing industrial and commercial exhibits, exhibits of the arts and crafts, archaeological and ethnological specimens, manufactures and horticultural and agricultural exhibits that will fill the exhibit buildings. Many spectacular features are being secured.

Feeding Refrigerating Coils*

SYNOPSIS—Various methods employed in the direct-expansion and flooded systems, and something on the merits of the apparatus used.

Feed systems for the refrigerator or expansion coil may be divided into three groups: The forced-feed or direct-expansion systems, the gravity-feed or flooded systems and systems which are a combination of the two. In any of these systems the refrigerant is admitted to the refrigerator coil by means of a regulating valve or cock. This valve is likely to clog up with dirt from the system, and it is practically impossible to so adjust a number of expansion valves feeding from a main liquid-supply pipe as to obtain an equal supply of refrigerant to each refrigerator coil connected to it.

top-expansion system has not been found more efficient than the bottom-expansion system, and in operation there is a chance of carrying liquid over to the compressor. The first named has been employed mainly in connection with horizontal compressors where wet gas has been preferred for operation, also where the forecooling tank coil of an ice-freezing system is so arranged that the return gas of the ice tank may pass through on its way to the compressor. The bottom-expansion system has been used by some builders of vertical compressors and in cases where dry gas is essential to the successful operation of the compressor. In this connection may be mentioned a system which will be called a horizontal-feed system. Its arrangement is shown in Fig. 2. It is fed by only one regulating valve. This system is used in a can-ice tank, and there



DETAILS OF APPARATUS AND SYSTEMS FOR FEEDING REFRIGERATING COILS

In Europe there is an appliance which overcomes most of the objections of the regulating cock or valve, in an apparatus which distributes the refrigerant to a number of coils of equal length by means of a revolving disk, which rotates over as many holes as there are coils. The disk has one hole which allows the refrigerant to enter each coil once during one revolution. Fig. 1 shows a section of this apparatus, in which *A* is the disk showing the inlet hole or opening over one of the distributing openings *B* in the body. These holes are arranged in a circle of the same radius as the inlet hole from the center of rotation. It is claimed that this apparatus makes a system 20 per cent. more efficient than when equipped with ordinary expansion valves. Doctor Linde, the inventor, is also the originator of a single rotating cock which works on the same principle.

In practice, refrigerator coils are fed in some cases from the top, and in other cases from the bottom. The

is another similar arrangement for the same purpose, but in this case each horizontal coil has its own regulating valve.

The deficiencies of the force-feed system, relative to proper feeding of a number of coils with one regulating apparatus or a number of coils with a regulating valve for each coil, are overcome by the gravity-feed or flooded systems, and besides, a greater part of the cooling surface is made efficient because the pipe is not needed as liberating surface. The invention of the first of these systems in this country dates back to the late eighties. Unfortunately, the inventor, H. J. Krebs, was not encouraged with the results obtained during the first tests as to the merits of the new system, and consequently further tests were abandoned, and the system was forgotten for years. Judging from the patent papers, it was well designed and would perform its duty today, but without the float-operated regulating valve for ammonia. For sulphuric-acid gas systems this float arrangement would probably have worked much better, as a larger quantity

*Abstract of paper read by S. H. Baars before the American Society of Refrigerating Engineers.

of refrigerant is required for the same number of heat units. This would not necessitate such a closely set opening, and again the difference in pressure between the incoming liquid and the refrigerator coil is about one-third that in an ammonia system. Apparently the float arrangement was replaced by an ordinary feed valve, and in this shape the system was manufactured, at least during the last few years of the life of the patent.

Two other gravity-feed systems are in use today which have the same advantages as regards the facility of feeding a number of refrigerator coils at the same time. One system patented by the late H. Rassbach has, as a special feature, the precooling of the refrigerant for the purpose of preventing excessive spraying of the entering mixture of liquid and vapor, the vapor being created by the sensible heat of the refrigerant.

The third system admits the refrigerant directly into the refrigerator coil and forces the vapor, liberated by the sensible heat of the liquid, to pass through the entire coil. The unevaporated liquid is allowed to return through a check valve. To make this third system equally as efficient, the circulation, and therefore the heat transfer, must be more rapid so as to take care of the losses due to the larger volume of vapor in the coil and a higher evaporating temperature.

Gravity-feed systems were also patented in Europe. The one patented by Schmitz in 1903 seems to be analogous to and of an earlier date than the third system mentioned. In Fig. 3, *A* represents the refrigerating coil, *B* the accumulator or separator, *C* the check valve and *D* the feed valve.

Professor Pictet also used in his binary system of refrigeration an arrangement which might be classed as a gravity-feed or flooded system; including the headers, it is identical with the aforementioned system. The suction and liquid headers were connected by a large vertical tube or so called accumulator, into which the liquid was fed. The system also met with a fate similar to the one designed by Krebs. The trouble was faulty construction of the coil so that it did not provide for a continuous upward movement of the refrigerant, causing the coil to become gas-bound and to offer too much resistance for the small liquid head.

Besides these two foreign systems, there are several operating more or less on the flooded principle. One of them is shown in Fig. 4. Here are two wide headers; the liquid enters the lower header and the vapor generated by the sensible heat of the liquid escapes through a large connection directly into the suction header. Otherwise the operation is the same as in the other gravity-feed systems.

Besides the force-feed and gravity-feed systems there are several combinations of the two, such as shell-type brine coolers, which can easily be operated flooded because they have a large liberating surface. A separator in the suction line, with a liquid-return connection added, will certainly insure as good a heat transfer as any gravity-feed system.

To improve the direct-expansion systems a separator has been installed in the main suction line leading to the compressor, but at such a height that the separated liquid can flow by gravity to a coil of sufficient surface to take care of its evaporation. The return of this coil goes back to the separator. The separator and the coil are on the true gravity-feed principle, with the exception that the refrigerant does not come direct from the liquid line, but from overfeed direct-expansion coils, the capacity of which had to be increased for some reason without increasing their surface.

An apparatus for the same purpose, but so arranged that the refrigerant is returned to the same refrigerator coil, has been in use in Europe since 1896. A diagram of the arrangement is given in Fig. 5. It has proved to be even more effective than the flooded system patented by Schmitz. In the drawing, *A* is the regulating valve, *B* the refrigerator coil, *C* the separator, *D* the pump which returns the unevaporated liquid to the refrigerator coil, and *E* is the suction line to the compressor.

As a development of the above, an apparatus has been designed which does all this automatically and also does away with the pump. In Fig. 6, illustrating this apparatus, *A* represents the suction from the refrigerator, *B* the separator, *C* the suction to the compressor, *D* the connection for unevaporated liquid to the regulating apparatus and *E* the equalizing line necessary to allow the

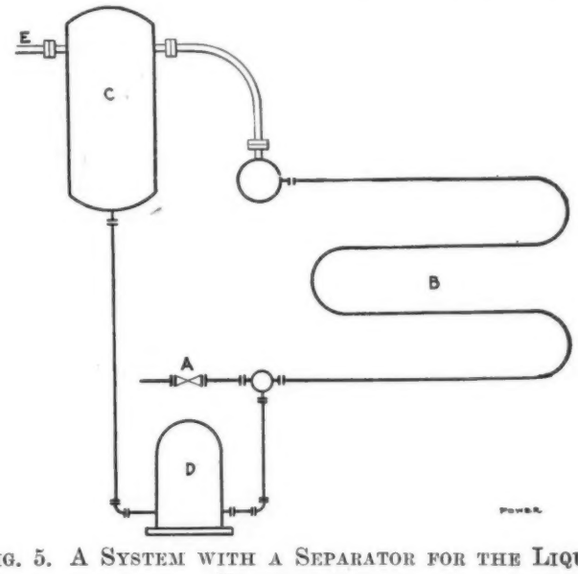


FIG. 5. A SYSTEM WITH A SEPARATOR FOR THE LIQUID REFRIGERANT

returned refrigerant to enter the regulating apparatus. In this apparatus there is a rotating feed cylinder *F* which has three chambers, each with one hole in the top and the bottom; the sections *ab* and *ef* show the holes in the top and the bottom plates between which the cylinder rotates; section *ef* shows connection *G* from the liquid supply valve and *H* to the refrigerator.

The feed cylinder is operated by a gear, and to get an idea of the working of the automatic regulating apparatus, the different phases of operation may be studied for one chamber during one revolution. Starting with the chamber in the position at the left side of the elevation, as in Fig. 6, it will be observed that the unevaporated liquid can enter the chamber and fill it with as much liquid as there is present in the separator *B*, which is equalized with the chamber *F* through the equalizing pipe *E*. Assuming that the cylinder rotates in the direction of the arrow, the next opening to be passed is that which registers with the opening from the condenser, and here the high-pressure liquid fills out whatever space there is left by the liquid returned from the system. Through communication with this opening, the refrigerant in the chamber is brought into connection with the condenser

outlet and given the necessary pressure required to make it flow into the chamber below, which it does in passing the third opening, where it registers during the next one-third revolution. Connected to the lower chamber is the liquid-supply pipe of the refrigerator coil into which the refrigerant passes to perform its refrigerating duty and in which it is partly evaporated. After leaving the refrigerator coil it again passes to the separator *B* where the gas passes to the compressor, and the unevaporated liquid again passes out through *D*, beginning another cycle of operation. The cycle is repeated with sufficient rapidity to properly feed the respective refrigerator coil. The simplicity of the regulation is due to the fact that if so much liquid is returned from the refrigerator coil as to completely fill the chamber of the feed cylinder, then there will be no refrigerant added while the chamber is in communication with the opening to the high-pressure

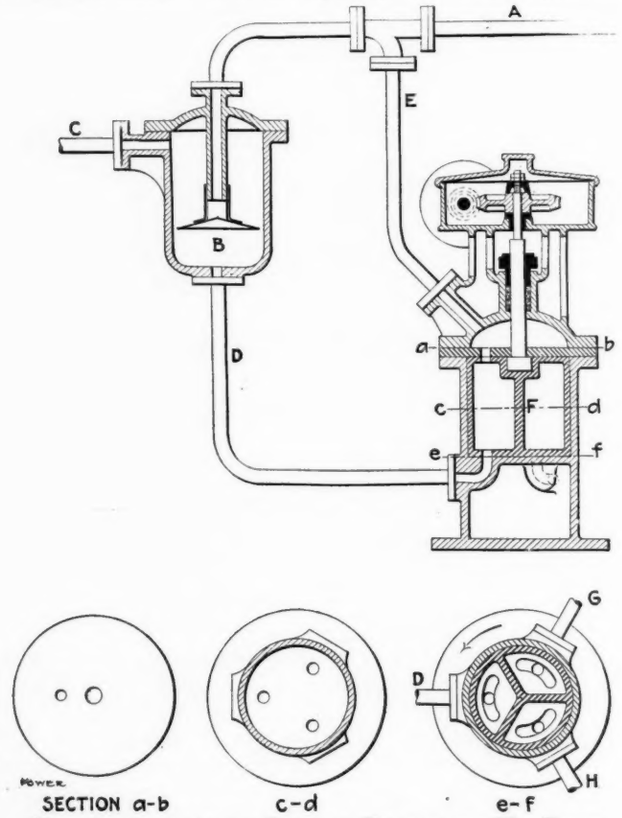


FIG. 6. AUTOMATIC SYSTEM REQUIRING NO PUMP

liquid inlet, but the pressure required to make it flow into the lower chamber is transmitted to it just the same through the condenser connection.

From the foregoing it can be seen that the designer's aim would seem to be to install a feed system which will have the cooling surfaces covered with the liquid refrigerant. There is another question to take into consideration, however, and that is the shape of the evaporating surface. As pipes are the most convenient surface the proposition reduces itself to the selection of the proper diameter of pipe to use, and here is the question: What pipe will give the largest surface for the least amount of liquid refrigerant, if the refrigerant is an expensive one?

In the accompanying table, line 1 gives the internal surface, in square feet, of pipes of various sizes containing one cubic foot; line 2 gives the cross-sectional area of the pipes in square feet, and line 3 the number of lineal feet of the various sizes for the number of square feet of internal surface given in line 1. It can be seen that the smaller the pipe, the smaller is the opening through

INTERNAL SURFACE AND AREA OF PIPES

Full Card-Weight Pipe

	Nominal Diameter, In.						
	½	¾	1	1¼	1½	2	2½
1	77.3	58.5	45.9	34.8	29.85	23.2	19.6
2	0.0021	0.0037	0.0060	0.0104	0.0141	0.0233	0.0332
3	473.8	270.0	167.2	96.26	70.73	42.91	30.34

Extra-Heavy Pipe

1	88.5	66.3	50.5	37.75	32.1	24.85	20.75
2	0.0016	0.00295	0.0049	0.0088	0.0122	0.0204	0.0292
3	623.0	338.6	202.8	113.3	82.1	49.05	34.2

which the refrigerant, evaporated by a given surface, can escape. This point is important as the pipe size has a great deal to do with the pressure required to circulate a liquid or vapor through a coil.

With the aid of the table it is possible to select the right pipe size for the refrigerator coil if the heat transfer is taken into consideration. For instance, one would probably select a ½-in. pipe for air cooling in which the coils are very short and large in number, and a 2-in. pipe for a coil in a long ice tank. After considering all this, the cost of the refrigerant may be balanced with that of the pipe coil and a final selection made.

From what has been published about the gravity or flooded system, one would infer that there are no further data required for their proper design, but as yet there is no information available which explains the relation between the height of the liquid level above the refrigerating coil and the velocity of the refrigerant in the refrigerator coil. There are so many varied conditions, due to length of coils, diameters of pipe and heat transfers under different conditions, that quite a field is open here for a careful study and for elaborate tests to improve this part of the feed system.

Measuring Air Velocities

Although the anemometer is not generally considered an accurate instrument, it is convenient to use and if carefully handled will at least give approximate results. A committee (C. A. Haslett, chairman) of the American Society of Heating and Ventilating Engineers recommends the following as a guide in using the instrument for measuring velocities at air-supply openings:

The opening should be divided into equal rectangular areas; no side of which shall be over 10 in. long, excepting where this would require more than 12 readings, in which case the opening shall be divided into 12 equal areas.

Readings are to be taken in each case at the center of each area.

Readings are to be of one-half minute duration, the anemometer being held against the register face or in the plane of the opening.

Where a diffuser is used, the total area is to be computed on the basis of the periphery of the diffuser.

The average of the readings is to be considered as the average velocity at the opening. Where negative velocities are found they are to be deducted in arriving at the average velocity.

In computing volumes, the net area of the opening is to be taken, the volume to be considered as the product of the average velocity and the net area of the opening.

If the anemometer is held 2 in. from the register face, no deduction shall be made for the area occupied by the register mesh.

Editorials

Safe Boiler Support

The importance of safe boiler support is not generally recognized, and the boiler laws that have been enacted in the various states and municipalities, do not seem to have taken into account its influence as affecting the safe operation of boilers. Anyone familiar with boiler explosions will be sure to feel that if a boiler should fall down while under steam, an explosion would be almost certain to follow; yet it is rare to hear this cause advanced as the explanation of boiler explosions where other causes are not in evidence. It seems more than probable that a good number of mysterious boiler explosions, occurring with sound boilers and where there has been conclusive evidence that no overpressure existed, may have been due to the falling down of the boilers or their changing position to such an extent as to result in the breaking of the pipe connections, thus producing the explosion of the boiler.

Investigation into the conditions surrounding the explosion of two sound boilers recently, seemed to indicate that the falling down of one of the boilers was the only reasonable explanation for the accident. These two boilers exploded simultaneously, the explosion of one having undoubtedly been the cause of the explosion of its mate. The tears through the shells of both boilers were similar, occurring through the top manhole reinforcement, which was of the outside pattern, and weak. The girth rivets at each end of the course that contains the manhole opening were sheared. All parts of the shell that were fractured were without evidences of defects, the tears being through the solid plate. Calculation showed that the structure should have stood about five times the load due to the steam pressure that was on the boilers at the time of the accident, and that there was not an excess pressure at this time was clearly indicated by the condition of the pop safety valves that were attached to the boilers. One boiler showed distinct marks on the manhole course of having been dented by a blow delivered to it by the manhole frame of the adjoining boiler when it exploded. From the nature of the breaks on these boilers, it is probable that the main steam connection on one boiler was broken by the falling down or settling of the boiler. The sudden opening and the resulting outrush of steam, caused a wave action of the water in the boiler, which resulted in its rupture girthwise and the manhole course lengthwise through the manhole reinforcement. This explosion probably would have been prevented if the boilers had been properly hung instead of depending on the settings for support.

The Massachusetts and Ohio rules prescribe that boilers above 78 in. diameter be hung, and that the support be independent of the setting walls. This provision was evidently made for fear that such large boilers could not be safely supported on the setting walls, which is doubtless correct. It would also seem to be a reasonable precaution to have all sizes of horizontal tubular boilers hung. The smaller size boilers are usually installed in the smaller plants where the condition of the settings is not as apt to be so closely watched as in the larger plants and small boilers for this reason are probably more likely to be exposed to the danger of explosion from improper support than larger boilers.

The American Boiler Manufacturers' Association, at its twenty-fifth convention, proposed that the Massachusetts Rules be modified in regard to the requirements for hanging boilers and that the boiler manufacturers be allowed to follow the present practice, which had been proved safe. Such a move would seem to be a step backward, and if any change is made it should be to require that the smaller sizes of boilers also be hung. It requires more than the mere statement of the boiler manufacturers to show that lug-supported boilers are safe, for there have been many instances to show that this means of support has often been the initial cause of boiler explosions.

Chimneys for Oil Fuel

Oil fuels have many advantages over coal, particularly for steamships and locomotives. For power-house work, they also promise decided benefits, many of which have been realized already and others will be when more is known of the art of burning oil.

The art of burning oil is comparatively new and calls for quite different conditions and design of plant than for coal burning. The important and governing condition in the economic use of oil fuels is the regulation of the air supply for combustion and the importance of this cannot be too strongly emphasized. Tests of many existing oil-burning steam power plants bring out two interesting facts; that the height of chimney necessary for adequate supply of air for combustion is much less than usually supposed or as usually installed; and, that the height required for plants subjected to frequent and severe overloads is considerably greater than has been ordinarily provided.

The high chimney, though supplying air in excess of that required for load or underload conditions, permits heavy overload and hence is particularly adaptable to city use where other conditions as well make the high chimney imperative. The greatly varying power requirements of city buildings due to lighting, elevator, ventilating, heating service, etc., can thus be taken care of by the tall chimney—the only type of chimney that can be installed. Even under such severe conditions, however, the chimney draft has been found to be excessive in many installations and more economical results obtained when the stack diameter has been somewhat reduced or the equivalent result obtained by constricting the cross-section by installing a damper. Securing the effect of reducing the chimney diameter in such cases simply reduces the air supply for combustion, again indicating that past practice has erred toward too great an air supply and that no rules for proportioning chimneys for satisfactory capacity when burning oil have yet been derived.

Economy, Real and Fancied

In the pursuit of the will-o'-the-wisp of economy in steam power plants, many fall into the bog of devotion to the one idea of low steam consumption. Let the designers of prime movers strive for that characteristic in each of the several types they produce, but the engineer to whom is entrusted the selection of the power-generating equipment for any given conditions has many other considerations to weigh against this one. Interest on the investment, depreciation and all of the multitude of costs that come under the head of maintenance, including labor, all too often are lost sight of in the effort for the greatest fuel economy. Locations there are where the high cost of coal justifies a heavy outlay for the most refined equipment, regardless of its expense and the space occupied and, then again, there are the places where the value of the land, with taxes and insurance, demand a compact installation. Much more common, however, are the situations where neither the fuel expense nor the property value are the main considerations.

It becomes ridiculous, as in the two illustrations mentioned in Mr. Longwell's paper on page 317, to seek to improve steam economy when the fuel costs nothing and there is use for low-pressure steam in excess of the amount available from the exhaust of prime movers. Evident as may seem the folly of substituting more efficient engines in such instances the fact remains that it took argument to dissuade those contemplating the changes from making them. Generally it is far less easy to distinguish between real and fancied economy and it is for that reason that the plea for a more rational study of each individual problem needs repeated vociferation.

It is a rare delight to us to be able to reprint such a paper as the one referred to, for the benefit of our readers and we cannot too strongly urge a careful reading of it. While the particular problem it discusses may concern a relatively small number and it would not be safe to take the conclusions it arrives at as applicable to many, if any, other fields or industries, for "circumstances alter cases," still, the method of analysis is so thorough and the treatment throughout so abounding in common sense, that it cannot help but be of value in a suggestive way to any who may now, or later, face the perplexing question of deciding what they should substitute for, or add to, their present installations. The important lesson to be gleaned from it is that it is dollars, and not pounds of coal, or pounds of steam, that is the true measure of economy and that this measure has not been properly applied until the problem has been examined from every angle and every contributing influence has been given due consideration..

Engine Inspection

A number of states and municipalities have laws which require that boilers be inspected by duly certified inspectors and certificates issued to permit their operation for a definite period of time. It would seem just as logical to require that engines also be regularly inspected to see that their operation is such as to comply with the usual and necessary precautions for safety. Why is it not just as necessary to protect life and limb from the results of flywheel explosions as from boiler explosions? The experience of insurance companies covering losses from these two kinds of hazard, show that a serious accident is more apt to be caused by the explosion of a flywheel than that of a boiler. A moderate-size engine with a large flywheel can store about the same amount of energy and is as capable of damage to life, limb and property as a small boiler. It is true that the path of probable damage in case of the flywheel explosion lies within more or less well defined limits, but the destruction within these limits is usually complete.

While it is a fact that where boiler laws are in force engineers' license laws are also effective, from the kind of examination questions usually asked the applicant for a license, it would seem that the intent of the examiner was to ascertain if the applicant could operate a plant economically rather than safely. Reasonable state or municipal requirements, regarding the application of safety appliances to prevent the racing of an engine, together with competent inspections, rules to govern the location of engines in the case of new installations, so that places likely to be occupied by a number of employees or the public would not be specially hazardous in event of the flywheel exploding, should be welcomed by all truly interested in "safety first."

Examination Questions

Anxious inquiries have come to us from places where engineers' license laws are about to go into effect, as to questions likely to be asked in the examinations. We cannot, of course, forecast the line of questions, which an examiner may see fit to propound, nor would the delivery of ready-made answers be to the best interest of all concerned. The questions are, or should be, framed for the purpose of determining whether the applicant is a *safe* man for the place or not.

The examiner should not concern himself whether the applicant has a vast fund of engineering information ready for immediate delivery or can capture all the elusive British thermal units and induce them to work overtime or not, that is the employers' side of the question. "Public safety" is the objective. Therefore, any engineer who knows that he can operate with safety a plant of the class for which he is seeking a license need have no apprehension in regard to the examination. The factors of safety to be demonstrated are good judgment and attentiveness. The first is based on training and knowledge of the principles involved and must be demonstrated to the examiner. The other is usually vouched for by two reputable citizens.

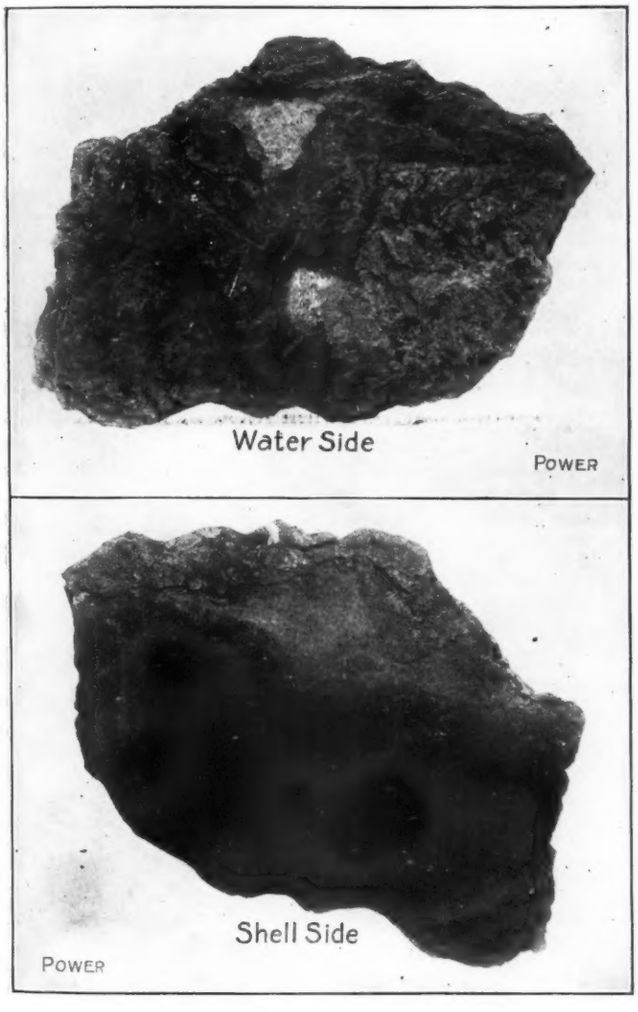
It is the privilege of the examiner to test, in any way he may think best, the mental alertness of the applicant, and he is sometimes justified in resorting to "catch questions" (like applying tension to a spring to observe the "come back"), but their use and weight should be limited. Best results are obtained by straight-forward, pertinent questions, answered as concisely as possible, without an effort to appear overwise, or to evade.

Those who have long advocated high boiler settings will be glad to know that the practice has received substantial approval by the designers of the new 201st St. station of the United Electric Light and Power Company, New York City. The tubes are ten feet above the stokers at the rear of the furnace.

Correspondence

Scale Removed by Graphite

The photographs show the front and back views of a piece of scale taken from the bottom front end of a 30-ft. x 8-ft. Lancashire boiler on which we have been using graphite for about three months. This boiler is one of a battery of three, fed from a dirty river, the water from which leaves moderately hard scale which



SCALE REMOVED BY GRAPHITE

formerly had to be chipped off, but since using graphite the boilers are as clean as it is practicable to get boilers. What little scale remains may be easily brushed or scraped off; it is not necessary to use a scaling hammer. On examining the front view it will be seen how effectively the scale has been driven off the shell plate and flues and collected in layers on the bottom of the boilers. The step caused by the butt strap, and several indentations in the plate caused by the unskilled use of a chipping hammer were visible on the back of the scale.

E. RUSSELL.

London, England.

A Solicitor's Experience

In the editorial of Jan. 20, entitled "What Engineers Want to Know," six reasons are given why contracts are made by large users of current with public-service corporations. A very frequent reason for the existing condition of affairs was omitted, however; this is the influential stockholder owning stock in both the selling and the purchasing company.

The writer had an experience in Worcester, Mass. some years ago, when soliciting the contract for heating and power equipment from the owner of a large department store. After figures were submitted, showing the financial advantage of installing a private power plant, which are readily acknowledged, the owner remarked:

"You may not know, but my father is a large stockholder in the local electric light company here, and we would not think of setting a bad example for our fellow citizens by installing our own plant.

"Even if it costs the store more, we think our interests lie in doing all we can to increase the business and prestige of the lighting company, thereby conserving our stock interest in that company as we personally will get it back in dividends."

If you seek deep enough, you will generally find some such condition behind "inexplicable" contracts.

IRA N. EVANS.

New York City.

Inertia in the Boiler Room

Inertia is that property which tends to continue a body in a state of rest or motion until acted on by a force. Few realize the importance of this law of mechanics. If we wish to tighten a hammer on its handle, we hold the handle in one hand and strike the opposite end from the hammer with another hammer and the handle is driven into the eye. This is owing to the inertia or resistance of the hammer to sudden motion as compared to the inertia of the lighter handle. Everyone knows how much more effective a jar is than a steady pull on the wrench handle in removing an obstinate nut, all of which is due to inertia. Many more illustrations could be cited, but one more will be sufficient.

A boiler inspector in a Pennsylvania coal-mining district was relating the ingenuity of the average imported citizen in overcoming common troubles in boiler operation; he had discovered them using an original method for properly seating lead gaskets on manhole openings of boilers. Those gaskets when new were found frequently to be poorly fitted and to leak.

With such troubles the need for removing the gasket was avoided by setting up tight on the bolts holding the manhole plate in place, and, with full steam pressure on the boiler, the proper seating of the gasket was readily accomplished by blows from a heavy sledge delivered on the manhole frame on each side of the leak. The discovery of this ingenuous method was due to the fact that

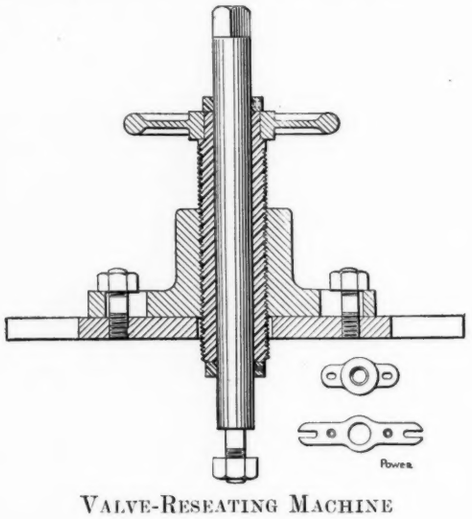
the manhole frames were of cast iron, were possessed of considerable weight and inertia, and exhibited their resistance to sudden motion by cracking and breaking in the places struck. In some plants, sledge hammers, like ferocious dogs, should be chained where they can do no harm.

J. E. TERMAN.

Hartford, Conn.

Valve-Reseating Tool

The valves and valve seats of a pump working against high pressure, in a short time, will become so badly cut by the water wire drawing through them that a large percentage of the water will slip back through the valves and around the plungers. This slippage may vary from 5 per cent. with the pump in good order to 85 per cent. with the pump in bad condition. This slippage reduces the capacity of the pump in proportion to the amount of slip, and causes it to require more steam and time to deliver a given



VALVE-RESEATING MACHINE

amount of water. The valves may be taken out and placed in the lathe to be refaced. The valve seats may be treated the same way, but as they are either pressed or screwed into the seats tightly they will be sprung out of shape in removing them, and, after being faced up true in this condition, will be sprung again in replacing them. For this reason they should be refaced in place.

It was decided to reface a number of seats in place, and the machine shown was constructed for use in any of several pumps, some of which were of the flat-valve type, and some of the pot-valve type with valve seats on an angle of 45 deg. The tool has a spindle, which is free to rotate but is held by collars against endwise displacement, in an adjustable threaded quill. Several cutters of different sizes were purchased to fit the valve seats of the various pumps. The body of the machine fits the seat on the pot-valve pumps, the bolt holes taking the valve-cap studs. The studs in the extension bar also fit these holes. When the machine is used on flat seats the valve-chamber studs are used to hold it solid, and a block under either end holds it high enough above the valve seat to allow the cutters to turn. After the valve and seats have been refaced those having brass valves are ground in with oil and emery or powdered glass, and those having hard-rubber disks are scraped to a good fit.

The valves are turned in grinding by means of a carpenter's brace. Some of them have a screwdriver slot in the top of the solid stem, and others are turned by means of a taper, one end of which fits the brace. Only a little time is required to grind them to a tight seat.

The valves should be examined at regular intervals, and it is a good idea to have a steam gage connected to the steam chest of the pump. When the valves get in bad condition a higher steam pressure will be required to supply a given amount of water, which signifies that the valves need attention.

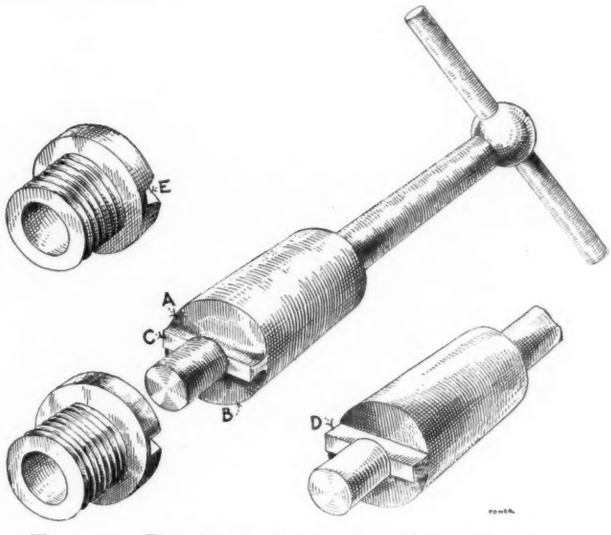
The blowoff valves on the boilers of this plant were of the angle type, with renewable disks faced with babbitt metal or soft composition, which could be changed by taking out two bolts and removing the bonnet. Several spare disks were kept on hand, and refaced in the lathe or rebabbitted when required. When the seats became worn, which could be easily detected as the ends of the blowoff pipes were exposed, they were refaced with this reseating machine. When they became worn down until they could be reseated no longer they were replaced.

J. C. HAWKINS.

Hyattsville, Md.

Condenser-Ferrule Tool

An efficient tool for removing condenser ferrules is shown in the accompanying illustration. It is made of a solid piece of steel, milled as shown at *A* and *B*, so that the end of the tool will have sharp gripping edges with which to turn the ferrule when fitted in the ferrule slot. The tool, when properly tempered, will last for years. Particular attention should be given to the shape of the driver end shown at *C*, which is of most importance.



TOOL FOR REMOVING CONDENSER-TUBE FERRULES, NOTE THE SHAPE OF THE TURNING LUG

I have used the same tool for several months on ferrules with the slots as badly worn as that shown at *E*, with the ordinary tool, *D*. When the edges start to wear out, the tool is useless, because it will not grip in the slot unless a heavy pressure is used to hold the tool in place. The ferrule is generally ruined in the process.

The tool, illustrated herewith, overcomes this trouble, due to the peculiar shape of the working end, which fits in the base of the slot in the ferrule and the turning

power is applied to the base of the slot and not at the outer edge. There is no ferrule too difficult to remove and there should be no leaky tube, as every ferrule can be put up tight against the packing and a tight joint made without injuring the slot.

J. A. LUCAS.

New York City.

Calking Tool in Blowoff Valve

The account of a fouled blowoff valve as related in a recent issue interested me as I had a similar experience.

Our boilers are blown down every six hours. Each blowoff line to each boiler is provided with a plug cock and an asbestos-packed gate valve. After blowing down one boiler I tried to close the gate valve but failed. Fortunately, the plug cock could be closed and the boiler left in service for two days.

A calking tool was found in the valve, notwithstanding that the boilers were inspected regularly and thoroughly, and the short vertical pipe to the horizontal line containing the valve and plug given special attention. The tool must have been in the pipe many months, having got as fas as the elbow and remained there until corroded enough to allow it to make the turn.

CLAUDE R. VAN KEUREN.

Famoso, Calif.

Proper Location for Vacuum Breaker

A mistake is frequently made in the method of applying a vacuum breaker to a jet condenser, especially in installations where a dry vacuum pump is used. The purpose of the vacuum breaker is to prevent the condensing water from flooding the exhaust in the event of failures of the auxiliary apparatus. In many instances the breaker is placed upon the condenser, and when it operates the air forces the water into the suction pipe of the vacuum pump, wrecking it.

The proper way to install a vacuum-breaking device on such condensing units is to place the float chamber as close as possible to the regular water level, then place the vacuum-breaking valve in the suction of the pump as near as possible to the cylinder, connecting the mechanism together by a light cable.

The operation of the device should be tested each time the unit is stopped by shutting down all auxiliary apparatus, leaving the injection or condensing water flowing into the condenser until the float operates the valve.

JOHN F. HURST.

Louisville, Ky.

High-Power Hydraulic Turbines

In an article on the Tallulah Falls hydro-electric development, in the Jan. 27 issue of POWER, the statement is made that the turbines are among the highest powered in the world, which is correct. But in the synopsis of the article they are declared to be the highest powered in the United States. This latter statement is incorrect.

The turbines in question are said to have developed 18,600 hp. under test, although rated at 16,000 hp. While this places them among the most powerful, they do not take precedence over all others in that respect. The most powerful turbine, unit so far built, will develop 25,000 hp. with the maximum gate opening. This unit, however, consists of two runners upon the one shaft, discharging into a common draft tube. It was built by the I. P. Morris Co. for the Washington Water Power Co.

The greatest power developed by a single runner is 22,500 hp. This wheel was built by the Allis-Chalmers Co. for the Pacific Coast Power Co. However, it has a double discharge. The largest single discharge turbines, of the type of the Tallalah Falls wheels, are of 20,000 hp. The Pelton Water Wheel Co. are building a reaction turbine of that type and size and the I. P. Morris Co. are building several of them.

R. L. DAUGHERTY.

Ithaca, N. Y.

Log for Absorption Plant

As I have never seen an absorption-plant log published in POWER, the accompanying form may be the means of drawing discussion regarding the different methods of recording the performance of this type of plant. Only a small amount of ice is made in the plant, the brine being used principally for cooling drinking water and the laboratories in which engineering and scientific instruments are tested.

Except when a special test is being run, making continuous operation necessary for several days, the plant is run during the night shift, four or five hours each night being long enough to take care of the increase of brine temperature brought about during the day.

H. G. GIBSON.

Washington, D. C.

Date ____ 191__ REFRIGERATING ROOM LOG

TIME	TEMPERATURE DEG. F.					PRESSURES							PUMP DISPLACEMENTS		BRINE METER READINGS
	BRINE		WATER			GENERATOR		COOLER	ABSORBER	BOILER	BRINE	CITY WATER	AMMONIA	BRINE	
	COOLER INLET	COOLER OUTLET	INLET	RECT. OUTLET		STEAM	AMMONIA								
Night 12:30															
1:30															
2:30															
3:30															
4:30															
5:30															
6:30															
7:30															
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11:30															

REMARKS

ENGINEER TO
ENGINEER TO
ENGINEER TO

POWER

Inquiries of General Interest

Reversed Polarity of Exciter—How may the polarity of an exciter which has become reversed be corrected?

D. G.

By lifting the brushes and then bringing leads over from another machine, or by closing the main switch on the machine itself so as to put a current through the field in the right direction.

Turning Size for Piston Ring—To what diameter should a piston ring be turned before being cut for a 14-in. diameter steam-engine cylinder?

M. O. D.

The ring should be turned off to a diameter of 14¼ in. and then have enough cut out of it to be sprung to the diameter of the cylinder.

Blackened Commutator Bar—If a commutator bar of a direct-current motor has become black, what does it indicate?

A. H.

That there is a short-circuit between commutator bars, or an open circuit in the armature, or a rough spot in the commutator, or that there is a loose commutator segment. If the blackening of the bar is due to an open circuit, there will be a vicious spark whenever the bar passes the brushes.

Expansion of Steam Pipe—If a steam pipe is 200 ft. long when put together at a temperature of 60 deg. F., what would be its total expansion in length when heated to a temperature of 300 deg. F.?

J. S. H.

For each degree Fahrenheit increase of temperature, iron or steel steam pipe expands about 0.0000065 times its length, hence by raising the temperature of 200 ft. of pipe from 60 to 300 deg. F. the increase of temperature being

$$300 - 60 = 240 \text{ deg. F.},$$

the expansion in length would be

$$240 \times 0.0000065 \times 200 = 0.312 \text{ ft., or practically } 3\tfrac{3}{4} \text{ in.}$$

Lift of Pump—If the steam pressure on a pump is only sufficient to force the discharge through a vertical pipe 80 ft. above the center of the pump-suction inlet, when the pump is supplied with water under only enough head to fill the pump, how high would the same steam pressure raise the water if the pump had to take its supply by a suction lift of 20 ft. below the center of the pump suction?

H. A. G.

Allowing the same loss of head from friction per foot of suction as per foot of discharge pipe, and assuming the suction pipe to be vertical, the net lift would be the same in each case and with 20-ft. suction lift the pump would raise the water

$$80 - 20 = 60 \text{ ft.}$$

above the center of the pump-suction inlet.

Pumpage of Oil vs. Pumpage of Water—If a given horsepower is required to pump 1500 bbl. of water per hour to a given height, then, neglecting any difference in pipe friction, how many barrels of oil with a specific gravity of 12 to 14 Bé. will be raised per hour through the same height by the same pump using the same power?

I. D. H.

The specific gravity of liquids lighter than water is found, from degrees Baumé, by the formula

$$\text{Specific gravity} = 140 \div (130 + \text{deg. Bé.}),$$

and taking the average as 13 deg. Bé., the average specific gravity of the oil would be

$$\text{Specific gravity} = 140 \div (130 + 13 \text{ deg. Bé.}),$$

or

$$\frac{140}{143} = 0.979;$$

therefore, the quantity of oil which could be pumped per hour would be:

$$\frac{1500}{0.979} = 1532.17 \text{ bbl.}$$

Transmissive Power of Belt—What horsepower can be transmitted by an open 10-in. single leather belt from a 40-in. diameter × 12-in. face pulley running 225 r.p.m. to a 30-in. diameter × 12-in. face receiving pulley, the shafts on which the pulleys are mounted being on the same level and about 15 ft. between centers?

F. B.

Under ordinary conditions of belt tension and friction between leather belts and cast-iron pulleys, it is practicable, with single leather belts, to allow a transmitting capacity of 1 hp. per inch in width of open-belt wrapping on a 30-in. diameter iron pulley running 100 r.p.m., i.e., with a peripheral speed of 785.4 ft. per min., and to assume that for different widths and peripheral speeds the power-transmitting capacity is in proportion. As the peripheral speeds of the pulleys will be directly in proportion to their diameters and speed, then for the example quoted, viz., for a 10-in. single belt wrapping over a 40-in. diameter pulley which runs at 225 r.p.m. the ordinary power-transmitting capacity would be

$$\frac{40 \times 225}{30 \times 100} \times 10 = 30 \text{ hp.}$$

Expenditure of Heat by Friction—Give a formula for the expenditure of heat in British thermal units required for overcoming the friction of one solid body sliding or rubbing over another?

R. L. Y.

The work performed in overcoming frictional resistance, expressed in foot-pounds, will be the total pressure in pounds with which the rubbing surfaces are brought together × the coefficient of friction between the bodies × the distance which one body slides over the other, and as 778 ft.-lb. of work is equivalent to 1 B.t.u., then if

H = Heat expended in British thermal units;
W = Weight or pressure in pounds with which the bodies are brought together;
C = Coefficient of friction for the conditions;
F = Space through which the sliding takes place;

then

$$H = \frac{W \times C \times F}{778}$$

Velocity of Pump Discharge—With a duplex pump having water cylinders fitted with pistons of 4-in. diameter by 6-in. stroke, and each piston making 100 single strokes per minute, what would be the velocity of the discharge in a 2-in. discharge line working against 80 lb. pressure per square inch?

C. O.

The area of a 4-in. diameter piston being 12.566 sq.in., with 4-in. stroke the displacement per stroke in the head end of each cylinder would be

$$12.566 \times 6 = 75.396 \text{ cu.in.}$$

Allowing that the piston rods are 1⅛-in. diameter, the cross-sectional area of each rod would be 0.994 sq.in., reducing the stuffing-box side of each piston to an effective area of

$$12.566 - 0.994 = 11.572 \text{ sq.in.},$$

and the displacement per stroke in the stuffing-box end of the cylinder would be

$$11.572 \times 6 = 69.432 \text{ cu.in.}$$

As for each piston there would be 50 strokes of 75.396 cu.in. and 50 strokes of 69.432-cu.in. displacement per minute, then the total displacement of both pistons would amount to

$$50 \times (75.396 + 64.396) \times 2 = 14{,}482.8 \text{ cu.in. per min.}$$

and allowing 10 per cent. slippage the actual discharge would be 90 per cent. of 14,482.3 = 13,034.52 cu.in. per min.

The cross-sectional area of a 2-in. diameter pipe being 3.1416 sq.in., then when discharged through a 2-in. pipe the water would have a velocity of

$$\frac{13{,}034.52}{3.1416 \times 12 \times 60} = 5.76 \text{ ft. per sec.}$$

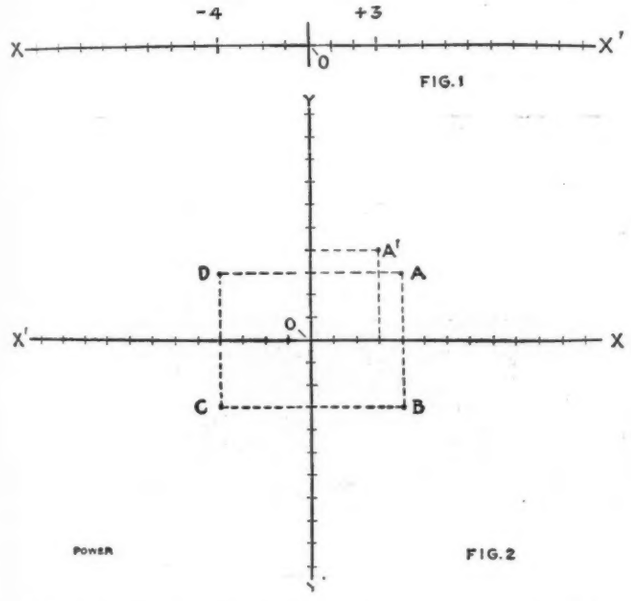
Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.

Engineers' Study Course

Curve Plotting--I

In general, curve plotting embraces the representation of numbers and equations by the relation of points and lines to base lines or a point. In this idea there should be nothing new to the engineer. He is used to looking at the charts of his CO_2 recorder, where varying percentages of CO_2 are represented by lines of varying length, or at the reports from his recording pyrometers and thermometers, or from his recording pressure gages, where variation in temperature and pressure are represented by differences in the distances of lines from a point at the center of the chart.

The utility of such charts is obvious from this use. The rise and fall of temperature are much more easily seen



in the kinks of the recording gage's curves, than they would be from looking at a number of readings.

The general method for the representation of numbers by lines we owe to the eminent French mathematician, Descartes. Imagine a line $X'OX$, Fig. 1, divided into equal spaces. We will call each space one unit, and will call those to the right of point O plus, and those to the left of point O minus. Then if $x = +3$, we count out to the right three spaces. If $x = -4$, we count out to the left four spaces. The $+$ and $-$ signs can be regarded in the same way as though one were told a house was at 1234 North Main or 1234 South Main St. It would make a difference which direction he started in, and only that. There would be just as many blocks to walk.

Or, to take another illustration, we may say it is 68 deg. or -3 deg. this morning, basing this on the distance a column of mercury is above or below a fixed point on a glass tube.

For most problems it is usual to have two lines along which we can measure. These lines we usually draw, for convenience, at right angles to each other, and call them $X'OX$ (known as the axis of X) and $Y'OY$ (the axis of Y)*. There is no absolute right or wrong about this. It is simply better if everybody agrees to draw $X'OX$ horizontal, and $Y'OY$ vertical. Then no long explanations are necessary—when one says the axis of X it is known immediately what is meant.

So, too, it has been agreed to call all distances to the right of O plus; all to the left minus; and all distances above O plus; and all below O minus (just as with sines and cosines in trigonometry).

We also agree, for convenience, that, given our axes of reference, and our scale, measured on both lines, see Fig. 2, we will always give the position of a point by the distances from the axes, and always name the x value first, the y value second. Thus, when we wish to speak of a point four spaces (its x value) from $Y'OY$ and three spaces (its y value) from $X'OX$, we say it is the point 4, 3, and to find it we measure an x out four spaces along the x axis to the right, then a y up three spaces, that is, parallel to the y axis.

Similarly, the point B is $+4$, -3; the point C is -4, -3; point D is -4, $+3$. (Work these out carefully, and make sure that the meaning of these signs is understood in each case.) We have seen that point A is the point 4, 3. The point 3, 4, would be a different thing. We would then count three to the right, and four up, and end at a point A' (Fig. 2). Try it.

To use a familiar analogy, we may imagine a rectangular room, square with the points of the compass. Were anyone to tell anyone else that he wanted a point marked out from the south wall and from the east, there would be no question what was wanted. So, too, after knowing the scale adopted, it is easily determined what point is meant if one says the point 4, 3; that is, x, the distance from the y wall is four, and y, the distance from the x wall, is three. We then measure these distances and find the point.

It is then possible, in this way, to represent any two numbers by a point, or conversely, to represent any point by two numbers, its coördinates. The x coördinate is called the abscissa of the point, the y coördinate is termed the ordinate. This again is a mere matter of definition.

For convenience, we usually find our points, and trace our lines, on paper that already comes ruled in squares, called "coördinate," or "cross-section" paper. The engineer is probably already familiar with such paper.

The indicator diagram is a familiar illustration of curve plotting to the engineer. In this case there are two variables, pressure, y, the ordinate; inches of stroke, x, the abscissa.

Another illustration which the engineer might use would be a chart on which is kept each day the number of tons of coal used. The abscissas would be 1, 2, 3, 4 days, the ordinates the number of tons, shown as a

*They are sometimes known as the axes of reference.

straight line extending up from *XOX'*, or as a point on the paper.

One particular reason for choosing this last illustration is to point out the essential difference which exists between a line connecting the points which show coal consumption, and the line on an indicator card. The line on the latter is a continuous one, and it is fair at any point on the stroke to point to the corresponding pressure and say, just at this time the pressure was 132 lb. However, if on the sixteenth, one burned 26 tons of coal, and on the seventeenth, 29½ tons, one cannot point along the line connecting these points (if he has drawn it), and say, at midnight on the sixteenth, we were burning at the rate of 27¾ tons. It may be true, but he doesn't know it.

In the indicator card, the lines are true mathematical lines, each point of which represents a definite pressure-distance relation. In the tons of coal diagram, each point represents an isolated, single fact, and the lines drawn between these points for convenience do not represent, in their intermediate points, any physical facts. In using lines in such diagrams, this point must always be considered. The above is an almost self-evident matter. There are times when the point is not obvious. There is probably no error which more often spoils otherwise good reasoning than does that of imagining that lines joining points, drawn for convenience only, have a physical meaning at intermediate points. They have not. The meaning is in the points, the lines are only good to enable the eye quickly to see the change of direction from point to point.

We have, then, in this paper, seen that any point can represent two numbers; that any two numbers, representing two mutually changing variables, can be represented by a point; and that there are certain conveniences obtained in such representation, this point being drawn from daily experience. In the next lesson we shall take up the representation of equations by lines.

Recent Court Decisions

Digested by A. L. H. STREET

When Power Machinery Does Not Become Part of Realty—Power machinery, although firmly affixed to real estate, will retain its character as personal property, so as to entitle the seller to reclaim it under a contract reserving title until payment of the purchase price, as against the buyer or a person who took a mortgage before the machinery was bought, even though the conditional sale contract has not been recorded. (New York Supreme Court, Appellate Division, Fourth Department; Ratchford vs. Cayuga County Cold Storage & Warehouse Company; 145 "New York Supplement" 83.)

Waiver of Delay on Delivering Coal—When a contract to sell coal requires delivery by the seller by a certain time, the buyer does not waive a claim for damages resulting from a delay in delivery by the mere fact of accepting delivery after the contract date; the acceptance merely waives any right to rescind the contract on account of the delay. (New York Supreme Court, Appellate Term, First Department; Molin vs. New York & Pennsylvania Smokeless Coal Company; 145 "New York Supplement" 116.)

Rights of Appropriators of Waters of Stream—The legal right of one who owns water rights in a stream by appropriation to acquire additional rights from other persons, and to change the point of diversion "is subject to the important qualification that the change of use or of the point of diversion must not be permitted to injuriously affect rights which have been lawfully acquired subsequent to the appropriation" by others. (United States District Court, Eastern District of Washington; United States vs. Union Gap Irrigation Company; 209 "Federal Reporter" 274.)

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

A Western "genius" is devising a plan to raise the "Titanic" by means of huge magnets. What he will probably raise won't need magnets—a storm of criticism will be about all.

In recording a Magdalena, N. M., gas-plant explosion, in which Hen Ellis and Joe Epplé were injured, the El Paso "Herald" says a Bible class has been organized at the Methodist church. Sounds like a new variation of the "safety first!" idea.

There's nothing craven about Chief Engineer Craven; he isn't even afraid to accept $20,000 a year from the New York Public Service Commission. Looks like the engineer is coming to his own. We really need other than lawyers to straighten out our business tangles, and usually an engineer can do the straightening if he's adequately paid for that same.

"Bananas and Tomatoes In the Canaries."—Daily Consular Report.

Those wise chaps who are helping the egrets figuratively to keep their shirts on came near being asked to extend their activities to the canaries, but on reading the article we find that bananas and tomatoes are merely products of the Canary Archipelago.

WANTED: AN AUTOMATIC STOKER

Wife of Smoke Inspector—"My goodness, John, how in the world do you ever hold your position?

Let it snow! What do we care. But, it costs New York City a million dollars each winter to clean the streets. Thanks to the suggestion of a correspondent to the New York "Times," it may now snow like ——— well, like it did Saturday, Feb. 14, and it won't cost the City a cent. Here's how he is going to do it.

"The average frontage of stores and residences is, we will say, 25 ft. On a 40-ft. street, with a 15-ft. sidewalk, there would be an area of about 900 sq.ft. covered with snow, say to the depth of 6 in. each side of the street. This makes about 450 cu.ft. of loose snow. If this bulk were taken into the basements of each building and placed in a box till it melted the space required would not be great.

"An arrangement could be made at small cost to construct a kind of receptacle or hopper to receive the snow, and this could be attached by a pipe to any sink or drain pipe so as to carry off the water as the snow melted. A lighted gas jet might be arranged so as to play upon the hopper, and thus melt its contents in a few minutes."

Of course, if the basement or tank is below the sewer level, one could install a small boiler and pump or an air compressor and ejector to handle the water. In summer the tank would make a good swimming pool, the snow chute serving as a slide. With proper accessories the tank might make a good rat trap.

Selecting a Prime Mover*

By H. E. Longwell

SYNOPSIS—A typical analysis of the problem of selecting the best type of prime mover for the generation of power. Specifically it refers to the problem in connection with the electro-chemical industries and more particularly the electrolytic refining of copper. By a process of elimination it is shown that, under the assumed conditions, first, a steam plant is to be preferred to a gas plant, then that, of the steam plants, attractive as is the reciprocating engine-turbine combination, it cannot compete with the turbine alone, and finally that a turbine with geared drive to a direct-current generator has advantages over an alternating-current, turbo-generator unit in combination with a rotary converter.

If one is designing a power plant, he must not become so obsessed with the question of mere steam economy that he will spend a dollar to save ten cents worth of steam, or ten cents to save some steam that costs nothing at all.

It is not unusual to find intelligent people who see the power problem with such a distorted perspective, that the single item of the steam consumption of the prime mover hides everything else. I recall two cases that were especially typical; one a wagon works in the West and the other a textile mill in New England. Both were using single-valve high-speed steam engines of a type that I regard with respect and affection, but which has been frequently and slanderously characterized as a "steam eater."

WHEN STEAM SAVING IS NOT ECONOMY

The manager of the wagon works admitted that he was getting reliable operation from his engine with a minimum expense for upkeep. However, someone told him that Corliss engines would do the work with 25 per cent. less steam and he was appalled by the ruinous waste. Now this work includes some acres of dry kilns which require more steam than the total exhaust of the engine; in fact, it was practically impossible to detect any measurable difference between the fuel consumption on Sunday, when the engine was not running, and any regular working day. The fuel was all refuse from the wood-working machines and there was always a surplus which had to be burned in a destructor. By patient reasoning with the manager, he was able to see that if saving all of the steam used by the engine did not effect any noticeable reduction in the total fuel consumption, it would be hopeless to expect any economic benefits to accrue from a saving of 25 per cent. of it; and finally it dawned upon him that, even if he could save a measurable quantity of fuel by installing another engine, his only return for the increased investment would be the joy of burning up his savings in the refuse destructor.

The textile mill mentioned engaged a new superintendent and he could see nothing ahead but bankruptcy, unless the wasteful high-speed engines were replaced by a compound condensing engine. In this mill sundry washing and drying operations used up all the exhaust of the engine and some live steam besides. Before committing any blunders, the new superintendent was deftly and skilfully assisted to an understanding of one fundamental principle of power plant economics, to wit: If all of the exhaust steam from an engine is required for some useful purpose, that engine is furnishing power with an efficiency of 10° per cent., and any expenditure with the object of bettering that efficiency is not likely to be a temptingly profitable investment.

I have put some emphasis on the policy of attaching too much importance to the question of mere fuel economy in a power plant, because I think I detect a little tendency in this direction in the presentation of the problem that has been submitted as a foundation for this discussion. Sundry estimates are submitted as representing the probable costs of steam and electrical energy exclusive of administration, taxes, depreciation, and electric charges.

CONSIDERATIONS NOT TO BE OVERLOOKED

The items of interest, taxes, insurance and depreciation, or to speak more exactly, amortization, are too important to be ignored. These so-called fixed charges or investment costs are in general, greater in amount than the total cost of labor, operating supplies and maintenance. They are especially significant in that they measure the cost of fuel economy.

WHY THE GAS ENGINE IS NOT ATTRACTIVE IN THE ELECTROLYTIC REFINING PLANT

To illustrate, let us consider the probable comparative performances of a high-grade steam turbine plant and a gas engine and producer plant consisting of several 1500-kw. generating units. The electrolytic refining industry offers any investment in the interest of economy an unusually favorable opportunity to "make good," because it is permitted to work 8760 hours per annum.

Assuming the fuel to be the highest grade of bituminous or semi-bituminous coal, having a calorific value of 14,500 B.t.u. per pound, the gas engine and producer plant would, under test conditions, effect the saving of one-half pound of coal per kilowatt-hour over the turbine plant or say, two tons per annum. If the coal costs as much as $3 per ton, this would mean a saving of $6 per kilowatt-year.

The gas engine and producer plant will cost about $50 per kilowatt more than the steam turbine plant and the question arises as to whether it is worth while to invest $50 in plant to save $6 a year.

Naturally, there will be differences of opinion as to what would constitute an attractive return on this extra investment. I should want 6 per cent. for interest, 1 per cent. for taxes, 1 per cent. for insurance, and 2 per cent. for maintenance, having due regard to the appalling speed with which new things in engineering become old, I shouldn't feel comfortable unless I had a sinking fund of 8 per cent. to provide for the safe return of my capital, for some of these items amount to 18 per cent. In my opinion the gross return should be not less than 20 per cent. per annum, so that this saving of $6 per kilowatt-year, would be too expensive if it required an extra investment of more than $30 per kilowatt in plant equipment.

In thus calling attention to the importance of investment for fixed charges as a factor in the cost of power, I am only touching superficially the doctrine, that has been ably and vigorously preached and assiduously practiced by Henry G. Stott.

The determination of the true cost of electrical energy is a large subject and those interested in it will profit by reading a paper entitled "Standardization of Methods for Determining and Comparing Power Cost in Steam Plants," which was presented jointly by Mr. Stott and W. F. Gorsuch at the June, 1913, meeting of the American Institute of Electrical Engineers and which is published in the May 1913, issue of the proceedings of that Society. This paper is particularly happy in its treatment of investment costs.

With respect to the type of power plant best suited for the electrolytic refining of copper, we may safely eliminate gas engine equipment from serious consideration.

THE ADVANTAGES OF STEAM IN THIS PROBLEM

The plant will naturally be located where there is abundant water available for condensing purposes, and where the cost of fuel is reasonable. In other words, we may choose a location where the conditions enable a steam plant to display its best economy. Under these conditions, the gas engine plant would be a doubtful investment, even were there no especial reason why it is not desirable for this particular class of work.

There appears to be one reason why the proposition is peculiarly one for a steam plant.

According to Mr. Addick's statement of the problem, if live steam were used for heating the electrolyte, the total steam from the boilers would be used as follows:

One-half for electric power generation, one-fourth for steam driven auxiliaries, and one-fourth for heating the electrolyte. Steam-driven auxiliaries are not, as a rule, so efficient that they abstract any serious amount of heat from the steam passing through them so that for heating the electrolyte the exhaust from these auxiliaries would be practically as effective as an equal quantity of boiler steam. Therefore, the boiler steam required for auxiliaries and for heating the electrolyte would be approximately 50 per cent.

*From a paper entitled "The Power Problem in the Electrolytic Deposition of Metals," presented at a joint meeting of the New York members of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Electrochemical Society, Jan. 9, 1914. Reported in "Power," Jan. 27, 1914, page 146.

of the amount required for generating the electric current.

I am informed that in a plant having an output of 500 tons of refined copper per day, the waste heat boilers connected to the reverberatory furnaces forming a part of such a plant, should be capable of supplying 50,000 lb. of steam per hour. This is somewhat over 40 per cent. of the steam required by the main generating unit or practically enough to operate all of the auxiliaries that would usually be run by independent steam motors in a steam-driven plant, and the exhaust from these auxiliaries would take care of the heating of the electrolyte.

This quantity of steam is too important to ignore and even though gas-engine-driven main generating units were installed, it would be necessary to make use of this steam from the waste heat boilers. The practical difficulty arises from the fact that while the tanks are operated continuously, it is not usual to run the furnaces on Sunday, consequently it would be necessary to have a considerable boiler plant in reserve to be operated only one day in each week to tide the plant over Sunday, and so, even if there were no question as to the commercial economy of a gas engine and producer plant, as a general proposition, this one practical operating condition would be sufficient to rob it of all of its theoretical advantages.

In a steam plant the regular boiler equipment is so flexible that it will readily take care of the fluctuation in the output of the waste heat boilers. Since with modern mechanical stokers it is not unusual to force boilers to 200 and 300 per cent. of their normal rating, it is evident that no decidedly disproportionate boiler equipment would be required to carry the plant over the weekly interval in which the waste heat boilers are out of commission.

THE ENGINE-TURBINE COMBINATION

The combination of a compound reciprocating engine exhausting into a low-pressure condensing turbine, looks, on first consideration, to be inviting, since it is generally admitted that, between the limits of the usual boiler pressure and atmospheric exhaust pressure, a reciprocating engine is usually more efficient than it is customary to make the portion of a complete expansion turbine that takes care of this part of the pressure range. While the superior fuel economy of this combination seems apparent from purely theoretical consideration, there is comparatively little available information regarding its amount in actual figures.

It is not denied that this combination has its legitimate uses, but it is most certain that mature judgment is required for determining the conditions under which it may be recommended, and it is equally certain that the combination has been installed in a number of instances in which its use was decidedly ill-advised.

Admitting the hypothetical economy of the combination, let us consider the features that tend to offset this advantage.

We have, first, increased the initial cost. A low-pressure turbine will in many instances cost 75 to 80 per cent. more per kilowatt than a complete expansion turbine. That this is reasonable may be seen readily by an inspection of a sectional view through a typical expansion steam turbine of the Parsons type. Let us assume that the capacity of this machine is 3000 kw. What must we do to break this 3000-kw. turbine into a low-pressure turbine of half this capacity? We simply cut out a small portion, and increase the inlet opening some six or eight times. But it does not require any unusual qualification to enable one to see that the part eliminated does not, by any means, represent one-half of the cost of the 3000-kw. machine. Neither would anyone expect to purchase 1500 kw. capacity in a reciprocating engine for the cost of the section that has been eliminated from the complete expansion turbine. Again, no one would claim that the expense of installing the combination unit would be less than twice that of installing the single complete expansion unit. And no one would be hardy enough to suggest that the charges for attendance, maintenance and operating supplies would be approximately equal for the two units.

There are doubtless cases in which the possibility of conserving reciprocating engines already in use would justify this combination type of unit, but in a plant that is new throughout, its desirability is, to say the least, highly problematical.

As far as actual authoritative figures giving the comparative power cost for the two types of units are concerned, Mr. Stott could give us these if he would. The most important installation of combination units in the world was carried out under his direction. He had the justification of conserving valuable reciprocating engine equipment, which was in excellent physical condition, and there can be no question but that the best possible engineering judgment was exercised in designing and executing the project. I am confident that Mr. Stott has accurate and comprehensive costs of electrical energy as generated by this plant and that these costs represent the utmost possibilities of this type of unit.

If Mr. Stott would be willing to say whether or not in an absolutely new plant he would seriously contemplate the installation of combination reciprocating engines and low-pressure turbine units, such a pronouncement would be more convincing than volumes of argument based purely on theoretical grounds.

WHEREIN THE TURBINE ALONE HAS THE ADVANTAGE

As regards the comparative merits of compound and triple-expansion reciprocating engines and turbines as prime movers, the trend of general practice in power plant design shows conclusively that the turbine has the advantage. It has economic possibilities at least equal to those of the reciprocating engine, and markedly better when working with the high vacuum obtainable with the newer types of condensing apparatus and the copious supply of cooling water that is invariably found in places that would be regarded as favorable for electrolytic copper refining plants.

I speak of the economic possibilities of a certain type of prime mover rather than of its inherent economy, because the latter is inseparably associated with the type. A prime mover is not economical simply because it is a compound engine, a triple-expansion engine or a turbine, but because it is economical by design. There are hundreds of triple-expansion engines that are less economical than some compound engines. In fact, I am not sure that there are authentic records of triple-expansion engines which show sufficient improvement over the economic results of the best examples of two-cylinder compound engines to justify the added complication and expense of the third cylinder and its connection.

It is possible to design a turbine that will be less economical than a very ordinary multiple expansion reciprocating engine. On the other hand, turbines are built that under suitable operating conditions give economical results that cannot be equaled by the reciprocating engines of any type, however skillfully designed, if operated under the same conditions.

The advocates of the turbine can afford to be unnecessarily modest and claim no more than equality with other types of prime movers as regards steam economy, for there remain still the unquestioned advantages of lesser cost and smaller installation expenses.

THE GEARED-TURBINE DIRECT-CURRENT UNIT

For some years the turbine was at a disadvantage in plants in which it was desirable to generate direct current, for the reason that the rotative speed of an efficient steam turbine and the rotative speed of a reliable, efficient direct-current generator are not compatible. This disability has happily been removed by the development of a reliable transmission gear which allows any reasonable speed ratio between the turbine and the generator. This gearing has an efficiency of over 98 per cent. and has been in public use long enough to demonstrate that, in point of reliability and durability, it is at least on a par with any other kind of apparatus forming a part of an electric power plant.

While the geared direct-current unit costs more than an alternating-current turbo-generator unit of the same capacity, it is cheaper and somewhat more efficient than the combination of an alternating current unit and a rotary converter.

I am not in possession of reliable costs for compound reciprocating engine-driven units, but commercial experience indicates that the geared turbine-driven unit has an advantage as regards price f.o.b. at the factory. With space and installation costs added, the advantage is obviously more marked.

Figures purporting to give probable plant and unit power costs are as a rule unsatisfactory because they are affected by too many variable factors. As regards plant costs, it might be said that, depending on the expensiveness, or simplicity, of one's architectural taste, his luck in selecting a contractor, his resourcefulness as a designer, his finesse as a buyer, the accessibility of the site selected, the state of the weather, and a lot of other things, he ought to be able to build a really good turbine-driven plant of from 6000 to 9000 kw. capacity for $75 per kilowatt, more or less.

As regards the cost of power, if one is satisfied with investment charges of 10½ per cent. per annum; if he can buy really good coal at not to exceed $3 per ton; if he is a capable manager and a careful operator, and reasonably economical, he ought, with a plant of this size, to be able to produce a kilowatt-hour at the switchboard with substantially 100 per cent. load factor for 4.3 mills, also subject to the qualification "more or less."

Congress and Water-Power Development

Dam sites, rate regulation and other matters pertaining to the development and distribution of hydro-electric power are on the cards to stir up controversy before the end of the present session of Congress. Following the recommendation of Secretary Lane, of the Department of the Interior, that there should be a letting down of the fences around dam sites in the public domain so that power plants can be constructed, the House Committee on Interstate Commerce has appointed a special committee to wrestle with the problem of how the government may permit private enterprise to develop hydro-electric power without creating unrestricted private monopoly. This committee consists of Representatives Adamson, of Georgia, Stevens, of Minnesota and Copley, of Illinois.

Some idea of the proposed legislation is suggested in the annual report of Secretary Lane, who says pointblank that the government ought to construct power plants and develop and distribute the electric power itself, but that he is afraid public sentiment is not sufficiently developed to make such a policy immediately possible. In the meantime, and until Congress gets ready to appropriate the money to do this work, he thinks private companies ought to be allowed to lease dam sites and construct works, which the government may have the privilege of buying after twenty years, and which will revert to the government at the end of fifty or sixty years.

Secretary Lane asks Congress to provide $100,000,000 more for extending the government's irrigation plants and building new ones, and points out that the government should regard this only as a loan, to be repaid out of the increased values given the land by irrigation, and the returns from power plants developed in connection with irrigation reservoirs, which he would have the government construct and operate as part of the irrigation works. The problem of what value to place on power sites, the Secretary admits, is a puzzling one.

"The country," he says, "has been aroused too late to save the richest points of vantage. Private power companies hold the most accessible of these dam sites under rights of which they can never be deprived. So much more compelling the reason why we should not yield what remain unwisely. The temptation to grant generously without condition that which may be put to so beneficent a use must be resisted if we are not to meet with a spendthrift's fate. At the same time there must surely be a rational way by which capital may be brought into this public service. The present conditions of stagnation do no one any good. Within a generation I believe the people will be as alive to the value of public ownership of hydro-electric power plants as they are today to the value of municipally owned waterworks.

"How may the needed advantage be gained for the present and the needs of the future be cared for? This is the immediate problem. What may capital reasonably demand? A fair and attractive return upon its investment yearly and the full return of its capital. And what may the public reasonably require? Good service and fair rates. Who shall make these rates? Within the state they must be subject to state regulation; between the states, Federal authority must control. What return shall the Federal government have for its lands? My answer would be, no return whatever, provided the plant reverted to the government without cost at the end of fifty or sixty years, or so much of the plant as was based on the land itself and the improvements directly attached thereto such as reservoirs, dams, water rights and the rights-of-way. For the tangible property of the plant, such as the distributing system and machinery, the government might well agree to pay an appraised price so as to insure its being maintained and extended during the later years of the life of the franchise. The right to buy the complete plant at an appraised figure at any time after 20 years would be a further protection, and one not burdensome, while for better service it would seem advisable that all plants be encouraged to physically combine, just as our railroads are required to couple themselves into through routes and thus make their service continuous and interdependent; but they should not be allowed either to agree as to the rates or to merge their capitalization or their identity.

"Such a plan as is here suggested should be attractive to capital wherever there is bona-fide need for such water-power development, for it is definite in its terms and can be made a precise basis for capitalization. The term of the franchise would be long enough to permit of the amortization of the plant upon such a percentage as would lay no heavy burden upon each year's earnings. Where a reservoir site is also used for the storage of irrigation waters, the right to which attaches to certain lands which should enjoy that use forever, it could be provided that at the end of the franchise period the government would either turn over the plant to the water-users or the state or otherwise provide for its operation."

Senator George Norris, of Nebraska, announces that he will try to secure a vote in the Senate on his bill to begin the development of hydro-electric power in the Potomac River, just above Washington. He wants the government to build the plants and operate them, and supply current for public and private uses in the city.

It is estimated that within 15 miles of Washington, there can be developed about 25,000 hp. of electricity, by damming the Potomac at three points. This project for giving the National capital cheap light and power has been talked of occasionally for the last 20 years, but nothing has been done about it, while a private corporation, developing power from coal, has been and is selling electricity for house lighting at 10c. per kw.-hr. and for business and power for anything it can get.

The Norris bill proposes a dam and power plant at the Chain Bridge in the Potomac, to develop 15,000 hp.

Representative Rainey, of Illinois, wants Congress to investigate the affairs of the Keokuk & Hamilton Water Power Co., and its several subsidiary and associated corporations, which own the big dam across the Mississippi River at Des Moines Rapids, Ia. This company was given a grant of the dam site by Congress in 1901. Its dam is the biggest in the world, is said to have cost about $15,000,000; it is nearly two miles long, and now develops 150,000 hp. although the ultimate development will be 300,000 hp. The franchise was granted in perpetuity, and the company is unregulated, so far as its rates and financial operations are concerned, neither the Federal government nor the state exercising any regulatory power over it.

When the company's franchise was granted, it was promised that by the building of the dam, the navigation of the river would be improved and the nearby cities and industries would be given cheap current. It is charged now that neither promise has been kept. Instead of improving navigation, it is claimed by steamboat men that the manner in which the dam is operated makes the river at times unnavigable, and instead of cheaper power, the hydro-electric company is gobbling most of the older light and power companies in its territory, supplying power from the big dam, and charging about the same high rates the people have always paid.

There is a confusion of corporations in the handling of the electric current generated at the dam. While the dam was built for the Keokuk & Hamilton company, it seems, the company that generates hydro-electric power is the Mississippi River Power Co. This company sells electricity through a subsidiary corporation, the Mississippi River Power Distributing Co., which is said to take a profit of two mills per kw.-hr. A single contract provides for the sale of 60,000 hp., or one-fifth of the potential development, to the Union Electric Light & Power Co. and the United Railways Co., of St. Louis. This contract is made for 99 years, and the St. Louis companies pay about six mills per kw.-hr. This single contract gives the dam company an income of $1,080,000 a year, or practically enough to pay the interest on its bonds and preferred stock, leaving (with the exception of the small operating charge) the company the returns from four-fifths of the capacity of the dam as profit, to ultimately be distributed to the holders of the $16,000,000 of common stock, which seems to have been given as a bonus with the preferred stock and bonds.

The two St. Louis companies to which the dam company sells this power at six mills per kw.-hr. are controlled by the North American Co., which, in turn, owns a large amount of the stock of the Mississippi Power Co., so that, in effect, the dam company is selling power and light to the people of St. Louis, and charging practically the same prices that were charged before the dam was built. Although the company delivers power to the distributing companies at six mills per kw.-hr. it is said that the lowest rate of the distributing companies is 3c. per kw.-hr. while for general lighting the St. Louis rate is from 6 to 9c., about the same as it was before.

Bills have been introduced in Congress by three members from Missouri proposing reductions in electric rates for St. Louis. Other cities getting power from the big dam have fared no better. Mayor Abbott, of Quincy, Ill., says that in negotiating a new contract for street lighting with the local company, he was told that they cannot furnish light any cheaper, although they are now getting current from the big dam.

At Warsaw, Ill., power is sold to the city and to private consumers by the Keokuk Electric Co., a subsidiary of the

Mississippi River Power Co. Mayor Louis Lament makes the following significant statement of the situation in Warsaw:

"The commercial lighting rate was reduced by the new company entering the field, but, strange to say, the old company is offering better rates than the new, although the latter is connected with the Keokuk company, and the old company is producing current from coal. This reduction is not very much, and it is clearly evident that whichever company forces the other one out, will again charge the old rate."

A score of other cities adjacent to the big dam tell the same story of disappointed hopes of getting cheap light and power from the dam. Evidence is presented by Mr. Rainey to show that the men who control the dam and power development are in close combination with practically all the utility corporations in the territory reached by current from the Keokuk plant, and that instead of the cities and power consumers getting any benefit in lower prices from the development of this great water power, the whole benefit is going in profits to the promoters.

Representative Rainey and other members believe that Congress has the power to annul the franchise of the dam company or to amend it in almost any way, and they are planning a fight to get some share of the benefits from the big hydro-electric development for the public. The company, however, contends that Congress has no power to regulate it or to modify its franchise. It rather looks as though the effort to get lower rates now was like locking the stable door after the horse has been stolen.

Years ago the government undertook to build a dam on the Mississippi at Rock Island. It was never finished and a flood washed part of it away. Some congressmen are now urging legislation to permit the completion of this dam, and with it the construction of a power plant to supply current for the government arsenal at Rock Island. Congressman Tavenner, who is among those urging this plan, also wants the government to build an armor plate plant at Rock Island, and use the current generated at the dam in the manufacture of armor plate for Uncle Sam's war vessels.

Mechanical Engineering Progress

At the recent convention of the Indiana Engineering Society, the committee on mechanical engineering, consisting of E. H. Ahara, C. B. Veal and J. D. Rigg, presented a report covering the whole field. The following two extracts are of most direct interest to POWER readers:

The internal-combustion engine has received much attention in the past year and is being gradually brought to greater perfection. In the stationary line many new designs are being brought out using the Diesel principle of constant pressure and injecting the oil, often low-grade, under pressure. This method is teaching us how to use crude oil advantageously and with great economy, thus conserving the supply of high-grade oils for use in the automobile engines. These latter are changed but little in the last year, except that a long stroke engine is now almost invariably used.

The latest design of producer-gas engine that has come to the public notice is one being developed for the Ford Motor Car Co.; a combination gas and steam engine, with two tandem cylinders on each side. Gas is to be used in two cylinders on one side, the cooling water from which is further heated from the waste gases in the exhaust and from the waste heat of the producers, before going to the boilers that supply steam to the two tandem steam cylinders on the opposite side. A large balance wheel is used to maintain steady operation. Greater economy is expected than has been heretofore attained by prime movers.

Water Resources of Southern Rivers—Water-Supply Paper 307, recently issued by the Unitel States Geological Survey, contains records of the flow of rivers in the Arkansas, Yazoo and Red River basins, tributary to the lower Mississippi, during 1911. Thirty-one stations were maintained in the basins of these rivers during the year. The Arkansas River records cover the principal upland tributaries in Colorado, together with Canadian River in New Mexico and White River in Arkansas and Missouri. A copy of this report or of Water-Supply Paper 287, which covers similar work in 1910, may be obtained free on application to the Director of the Geological Survey, Washington, D. C.

BOOKS RECEIVED

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer. McGraw-Hill Book Co., New York. Cloth; 378 pages, 6x9¼ in.; 174 illustrations. Price $3.

ELEMENTARY MANUAL OF THE STEAM ENGINE. By Ernest V. Lallier. D. Von Nostrand Co., New York. Cloth; 266 pages, 5¼x8 in.; 102 illustrations. Price $2.

MECHANICAL LABORATORY METHODS. By Julian C Smallwood. D. Van Nostrand Co., New York. Flexible leather; 333 pages, 5x7½ in.; 95 illustrations. Price, $2.50.

ELECTRIC LIGHT AND MOTOR WIRING. By George J. Kirchgasser. Electroforce Publishing Co., Milwaukee, Wis. Flexible leather; 270 pages, 3x6 in.; 150 illustrations. Price $1.

Bulletin No. 58, issued by the Bureau of Mines, Department of the Interior, gives an account of the fuel briquetting investigations carried on from July 1904 to July 1912, by C. R. Wright. The bulletin contains 277 pages, 21 plates with figures, and may be had by addressing the bureau.

The sixth edition of the Electrical Blue Book, issued annually by the Electrical Review Publishing Co. of Chicago, is now in print. It contains a very complete list of approved electrical fittings with the names and addresses of the firms making them, besides 80 pages illustrating construction material. In an appendix are included the National Electric Code, illustrated and explained, and a compilation of useful information such as Wiring Calculations, Illumination Calculations, Treatment for Electric Shock, Rate Charts, Street Lighting Schedules, Motor Applications and Ground Detectors. The price is 25c.

Explosion of a Compressed-Gas Cylinder on the "Mauretania"—Recently, a disastrous explosion occurred on board the Cunard liner "Mauretania." The vessel was lying in Canada Dry Dock undergoing engine repairs, which included the insertion of a number of blades in the high-pressure turbines. For this purpose an autogenous welding plant was being used, and it is stated that, without the slightest warning, a cylinder of compressed gas in connection with the plant burst, with terrible results to about a dozen men engaged in the room at the time, three being blown to pieces, and eight others injured, some of them so terribly that it is doubtful if they will survive. The cause of the explosion has not been ascertained, but will doubtless be inquired into at the inquest.—"Mechanical Engineer."

Wider Powers for West Virginia Commission—In a recent decision by the Supreme Court of Appeals of West Virginia against the United Fuel Gas Co., which asked that an order of the Public Service Commission be suspended, the court stated that under the law the orders of the commission are final and not subject to court review unless they are beyond its statutory power or based on a mistaken interpretation of the law. This apparently gives the West Virginia commission almost unlimited power over rates and regulation of public-service corporations operating in that state. In the case in question it was contended that the company charged a regular rate of 25c. per thousand cubic feet for natural gas, reducing the rate to 22c. on five-year contracts. The commission ordered the practice abandoned and the decision was upheld by the court.

A Quarter Million Tons of Coal in Storage—A fuel agent and thirteen clerks are necessary to conduct the work of the fuel department of the Commonwealth Edison Co. and some of the allied Insull companies, according to C. E. McBride, who recently read a brief paper on the subject at a company section meeting of the N. E. L. A. The Commonwealth Edison Co. burns about 5000 tons of coal daily and its coal bill is about $2,000,000 a year. About 250,000 tons is kept in reserve in or near Chicago at all times. Nearly all of this is of egg or lump size, as the danger of fire from spontaneous combustion is much less with the larger sizes. Thermometers are placed in all coal piles and weekly records of temperatures are taken. It is frequently found necessary to move piles of screenings or mine-run coal to prevent or fight fires.